Horizons

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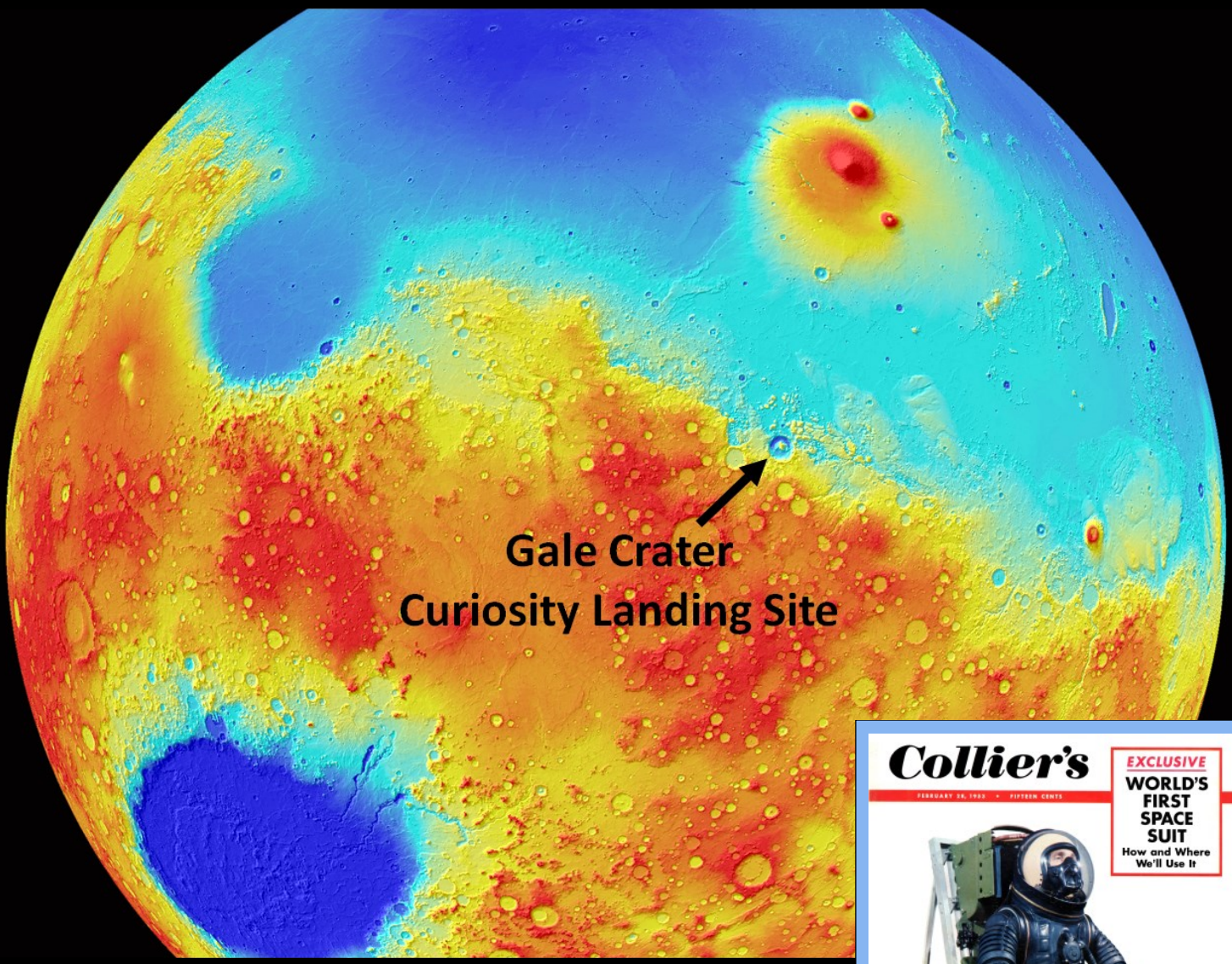
The Newsletter of AIAA Houston Section
The American Institute of Aeronautics and Astronautics

January / February 2013
www.aiaahouston.org

A Geologist and Curiosity on Mars

Interview with Dr. Dorothy Oehler



Also, Continuing in this Issue! Part 4 of 8:

Man Will Conquer Space Soon!

(Collier's 1952-54)

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Horizons, Newsletter of AIAA Houston Section

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Cover: Gale Crater context image, showing location of the crater on the dichotomy between the southern highlands and northern lowlands of Mars. Image is color-coded elevation from the Mars Orbiter Laser Altimeter (MOLA) that was on NASA's Mars Global Surveyor orbiter. Reds are elevations above 2600 m and dark blues are elevations below -5200 m, with respect to the Martian datum. North is up. Image created by D. Oehler. MOLA image data credit, NASA/ Goddard Space Flight Center. Table of contents page: part of Vincent van Gogh's 1889 painting The Starry Night.

Horizons is a bimonthly publication of the Houston Section of The American Institute of Aeronautics and Astronautics.
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AIAA Houston Section Technical Committees

From the Chair

DANIEL NOBLES, CHAIR

Technical Committees are the heart of the AIAA Houston Section. This is where colleagues gather to swap ideas, learn from one another, and as a group can bring in fascinating speakers to lunch and learns on topics that interest them. They allow you to do your job better, and make friends that can help you in your career.

The mentoring that committee members experience can truly make a difference in your career. If you are a member of the AIAA in order to attend conferences and join national technical committees, then you are truly missing out on some of the best benefits of your membership. Please attend our Annual Technical Symposium and discuss your qualifications to join a Houston Section Technical Committee. We accept everyone from students to seasoned graybeards. Perhaps now is the time to really gain the full benefits of AIAA membership.

The expectations for committees are simple: meet the group at least twice a year and set up two lunch and learn sessions per year. That being said, not every member is expected to attend every meeting or lunch and learn. Work comes first, but when time permits, you will never regret joining a technical committee. It also adds food for discussion during those annual performance appraisals. Stand out among your peers. Join an AIAA Houston Section Technical Committee and show your boss that you are committed to your field.

If three people are interested in starting a new technical committee such as payloads or space commercialization, we would be happy to create a new technical committee for you and assist you in recruiting new members.

Current technical committees are: Astrodynamics; Automation and Robotics; Program Management & Integration; Extravehicular Activity; Guidance, Navigation, and Control; History, In-space Imaging and Crew Observation; Space Operations; Life Sciences, Space Processes and Human Factors; Propulsion and Power Systems; Safety and Mission Assurance; Systems Engineering; Space Commercialization; and the International Space Activities Committee (ISAC).

We also have numerous other groups that you could join if you have an interest in setting up Programs, learning Journalism, web development, mentoring children, or Public Policy. With elections around the corner, feel free to talk to one of us about getting more involved in a leadership role (elected or appointed).

chair2012@aiaahouston.org
(Daniel A. Nobles)
Links:
https://people.nasa.gov

AIAA
American Institute of Aeronautics and Astronautics
Houston Section

Annual Technical Symposium

Image Courtesy of Wikipedia

May 17, 2013 (Friday)
Gilruth Center
NASA/JSC
Walk-ins Welcome

INCOSE
International Council on Systems Engineering

Invited Speakers

Invited Morning Kickoff Speakers
Anousheh Ansari, *Commercial Space*
Jemison Group, *100 Year Starship*

Invited Luncheon Panel
Scott Kelly, JSC Center Director Ochoa, Jack Bacon, James Oberg, Art Dula
Human Space Policy

Schedule

0745	Registration (*open all day*)
0815	Morning Keynote Speaker
0900	Morning Sessions
1230	Afternoon Keynote Panel
	Lunch (provided by Gilruth) Optional but requires reservation by Thursday, 5/9/13 (A limited number is available after that time)
1330	Afternoon sessions
1630	End of Symposium

Deadlines

April 29, 2013 (Monday)
Abstracts due online
May 6, 2013 (Monday)
Abstract acceptance notices sent out
May 9, 2013 (Thursday)
Reserve optional lunch
May 17, 2013 (Friday): ATS
Registration all day

Proposed Topics

- Space Exploration
- Space Commercialization
- Systems Engineering
- Astrodynamics
- Avionics and Software
- Structural and Mechanical Engineering
- Robotics
- Guidance, Navigation, and Control (GN&C)
- Extra-Vehicular Activity (EVA)
- Aerospace Technologies
- Space History (Including Skylab 40th Anniversary)
- Climate Change Science & Public Policy

Symposium Plans

Registration all day at the Gilruth Center 0745-1630
$15 for Presenters and Attendees (lunch included)
Register and Pay Online: www.aiaahouston.org.
Advance reservations are required for those selecting the optional lunch buffet (see deadlines)
Civil Servants (CS) should register through SATERN (search "AIAA" in the catalog). CS registration fee will be paid if registering through SATERN.

Presenters: see deadline for abstract submission

AIAA membership and JSC badging not required

Presentations limited to 30 minutes
Laptop computers and computer projectors provided

No paper required
Only abstracts will be published.

Complimentary coffee, beverages, and snacks

Lunch available
Reserve online in advance (RSVP by 5/9/13)
Lunch includes vegetarian option

All are encouraged to attend or present

Take advantage of this opportunity to present your current efforts and to showcase your company or organization

Contact

Ellen Gillespie, General Chair
councilor1-2012@aiaahouston.org

www.aiaahouston.org

From the Editor

Curiosity on Mars and a Busy Horizons Team

DOUGLAS YAZELL, EDITOR

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www.aiaahouston.org
An archive for Horizons on a national AIAA web site is here.

Submissions deadline:
April 9, 2013, for the March / April 2013 issue, to be online by April 30, 2013.

Advertising
Please contact the editor about rates.

Special thanks go to Dr. Dorothy Oehler for our cover story this issue. She worked with me patiently during a busy time for her work on this inspiring project.

Wes Kelly suggested the article about the late science fiction writer Boris Strugatsky, and I enjoyed learning about the writings of the Strugatsky brothers. Thanks to this article, we also have a new resource for Horizons reporting, the biweekly Russian language newspaper Our Texas. The NASA/JSC family includes a Russian community thanks to ISS work, and projects like this article can expand Horizons readership. Wes Kelly contributed another article in response to my request, a report about the Tau Ceti candidate exoplanets.

Our French sister section 3AF MP has been great about exchanging newsletter articles, and that tradition continues in this issue. In related news, Orion is going international. The Orion ESA service module is very big news for our NASA/JSC community. This issue includes a NASA press release and a reporter's contribution to the question and answer session during the NASA/JSC press conference.

The alligator in the photographs below has been living in that ditch in the center of Bay Area Blvd for a year or two, my neighbor tells me. I took those snapshots while the gator spent a few days just east of Boeing Way, a short street which exists only to cross Bay Area Blvd as part of the entrance and exit for the Boeing parking garage. As shown in one of the images, the gator is only about four feet long and its weight is about 70 pounds, I would guess. There are plenty of turtles in the ditch, too, so maybe that is its diet. Adult and baby ducks sometimes wander into those ditches from behind the Boeing building, so I hope they stay away from the gator. Small dogs walk near there now and then, but the dogs are safe while being walked on leashes by owners. The University Park neighborhood web site has more photos which serve to keep those residents informed and warned.

Right: Astronauts for Hire (www.astronauts4hire.org) published their third quarterly newsletter.

A Geologist and Curiosity on Mars

Cover Story

DR. DOROTHY OEHLER, CURIOSITY PARTICIPATING SCIENTIST, INTERVIEWED BY DOUGLAS YAZELL, EDITOR

Dr. Oehler is a Senior Scientist in the Astromaterials Research and Exploration Science (ARES) Directorate at Johnson Space Center.

Please tells us about your travel to California from Houston and working there on Mars time.

I went to Pasadena, California for the landing of Curiosity with my husband, John, and another couple from Houston. We were all at Caltech that evening where they had 3 huge screens set up outdoors for folks involved in Mars Science Laboratory (MSL) to watch the various events associated with the landing. There were several thousand people there. Shortly before the landing, the International Space Station passed overhead and was clearly visible. The crowd cheered. When the landing was taking place, you could hear a pin drop. After landing, there were tears in some eyes. Landing was around 10:30 pm, Pacific Daylight Time (PDT), and soon after that, I went to the Jet Propulsion Laboratory (JPL) (just a few miles away from Caltech) and began my first "day" on Mars Time. All the scientists were there and work proceeded immediately that evening. I finished that first "Mars Day" of work around 8:30 am PDT.

What did you propose to win this role as a Participating Scientist?

I proposed to help focus the search for ancient biosignatures (evidence of past life) in Gale crater.

Organic materials constitute some of the best preserved and least ambiguous remains of ancient life on Earth and it is thought that organic materials may also provide evidence of possible past life on Mars. However, because the surface of Mars appears to be oxidizing and destructive to organic compounds, it will be necessary to select areas in which to search for organic remains very carefully.

My background includes 20+ years of research and exploration in the petroleum industry where I studied organic materials in sedimentary rocks. That work included study of various types of biosignatures, the geologic contexts in which organic biosignatures occur, and the characteristics of organic biosignatures at microscopic scales (in thin section) and macroscopic scales (in outcrop). So I proposed to use my background to help identify optimum localities for biosignature exploration by Curiosity, by targeting specific portions of outcrops at MSL investigation sites for elemental, mineralogical, and chemical analyses and providing insight regarding geologic facies that can add to interpretation of MSL data throughout the mission.

What is your role on the team? Geologist?

As a Participating Scientist, I interact with other geologists and geochemists. We have divided ourselves into "theme" groups and I usually work within the group that assesses geologic and mineralogic data. We look at the images and spectroscopic data that come down each day, and we plan the next day's activities based on what we have seen. Our group is highly diverse and we have participants with expertise in many different areas (e.g., chemistry, biology, soil science, fluvial and aeolian geologic systems, igneous processes, clay mineralogy, glacial processes, various types of spectroscopy, etc.). We also discuss longer range plans and strategy for obtaining the best scientific results.

Above: NASA Mars Science Laboratory (MSL) logo featuring the Curiosity rover. Image credit: NASA.

At the end of most days, we have a 1.5 to 2 hour Science Discussion that is open to the entire team. We each give presentations at those Discussions, when we see areas in which we can contribute information relevant to current and planned activities. Some of those discussions are detailed with lengthy questions and follow-up. While we were all still in Pasadena at JPL and working on Mars Time, some of the most intense Science Discussions ended up being at 2 or 3 in the morning!

How many Participating Scientists were selected?

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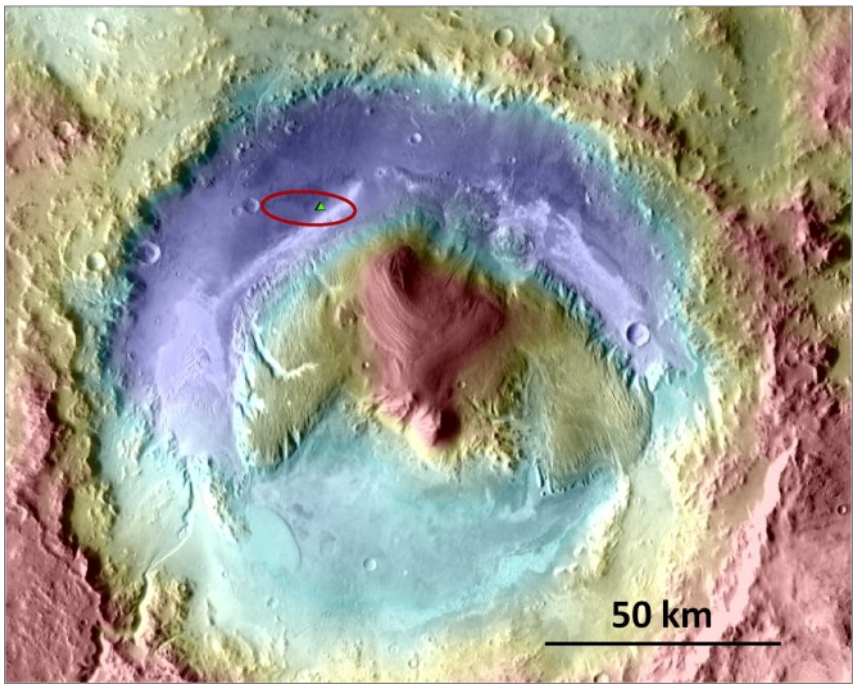

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There were 29 Participating Scientists selected to be on the mission. And there are thousands of people who have worked on Curiosity (if you count all the engineers who helped to design and develop Curiosity and who help with the day to day operations). I am part of the Science Team which includes the Participating Scientists as well as scientists who are members of the various Instrument Teams. The whole science group consists of about 400 members and includes representatives from the United States and many other countries including the United Kingdom, France, Spain, Denmark, Germany, Mexico,

(Continued on page 7)

Fig. 1. Gale Crater showing landing ellipse (red oval) and Landing Site (green triangle). Image created by overlaying elevation data from the Mars Orbiter Laser Altimeter (MOLA) on Daytime Infrared Data from The Thermal Emission Imaging System (THEMIS). Red colors are elevations higher than about -1500 m while the dark blues indicate elevations below about -4200 m. North is up. MOLA image data credit: NASA/Goddard Space Flight Center. THEMIS image data: NASA/JPL-Caltech/Arizona State University.

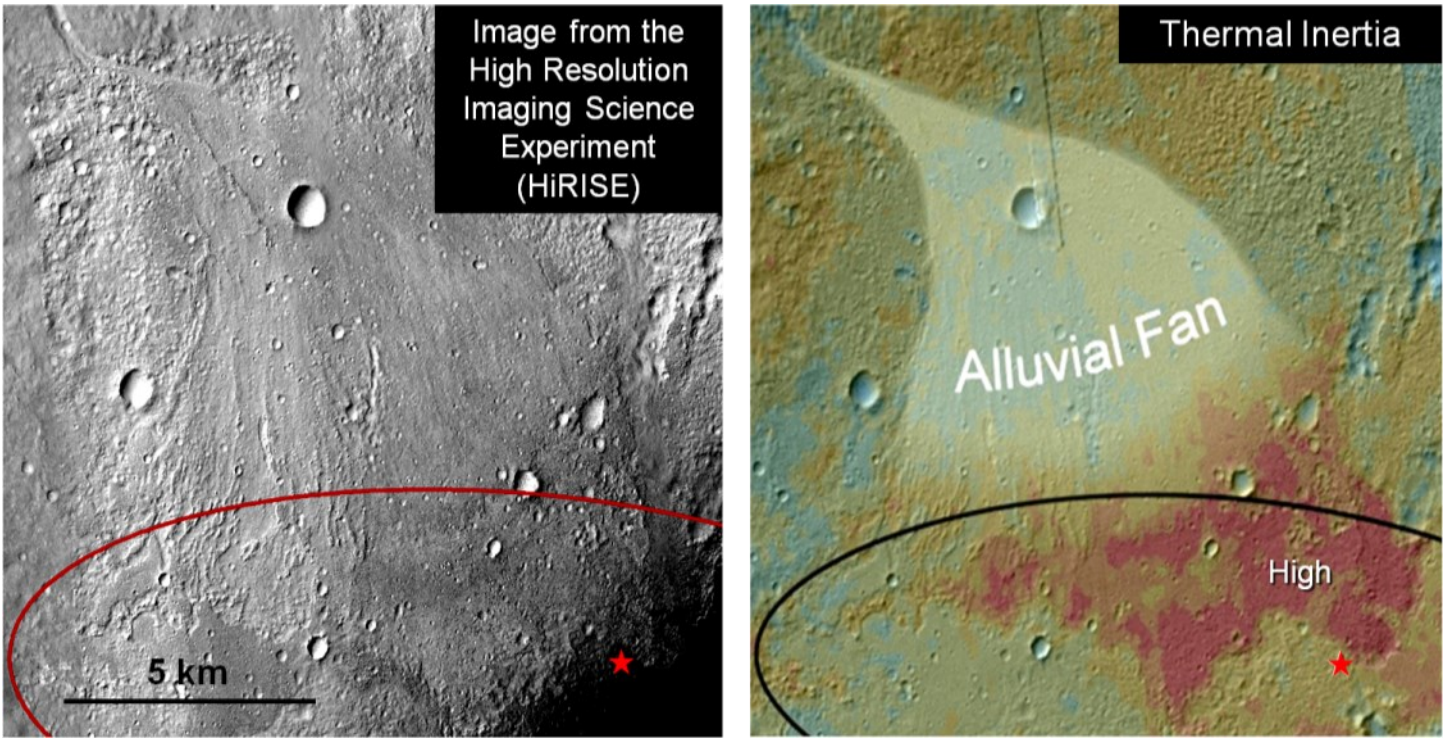

Fig. 2. Alluvial fan (left) and high thermal inertia unit (right) in Curiosity's landing ellipse. Red star is Curiosity's landing site. Left panel: HiRISE image of the alluvial fan that originates from the NW rim of Gale crater and travels into the area of the landing ellipse (portion of red oval). HiRISE Image credit, NASA/JPL/University of Arizona. Right Panel: High thermal inertia unit. False-color map merging topographic MOLA data with thermal inertia data, and illustrating location of this unit distal to the alluvial fan. North is up. Thermal Inertia data obtained with THEMIS spectrometers on the Mars Odyssey spacecraft, colored so that reds are high thermal inertia. Image credit: NASA/JPL-Caltech/ASU.

(Continued from page 6)

Canada, Japan, Russia, and Australia.

What is of note in Curiosity's results so far?

Gale crater includes a 5.5 km high, central mound of sediments that is surrounded by a moat-like topographic low. MSL landed on the topographic low (Fig. 1), about 400 m from a region that had been of interest prior to landing because of its location distal to what appeared from orbital image data to be a cone-shaped feature that originated on the rim of crater and spread into the moat. This type of feature resembles those on Earth that are commonly deposited by streams (and called alluvial fans). In addition, that distal region was characterized by relatively high thermal inertia (also determined from orbital data). Thermal inertia is a material property that influences the slowness with which the temperature of a material approaches that of its surroundings. Thermal inertia can be influenced by grain size and mineralogy, among other factors, and the fact that the thermal inertia of the distal region appeared distinctive could have reflected unusual rock formations at that locality (Fig. 2). Since Curiosity landed so close to this unusual unit, the Science Team decided to travel there first. Curiosity has now arrived at that unit and is beginning to assess sediments in the part of it that has been called Yellowknife Bay (YKB).

During the traverse to YKB, Curiosity spent much of its time characterizing all of its different instruments - checking their health and performing First-Time-Activities (FTA) on each. Those activities are completed now. Everyone on the mission is pleased, as one by one each instrument has been tested and has performed excellently.

Notable results on the way to YKB include

1) Identification with images from the Mast camera (Mastcam) of a rock outcrop that appears to be a pebble conglomerate. Because this rock includes fairly large rounded pebbles, it is likely that the conglomerate was formed as a result of a major and vigorous stream that flowed into the crater.
2) Analysis of various ejecta clasts by the Chemistry and Camera (ChemCam) laser instrument and the Alpha Particle X-Ray Spectrometer (APXS). Both instruments give indications of elemental composition. Results suggested that these ejecta blocks are alkali basalts, a type of igneous rock not yet seen on Mars. These data suggest that igneous processes on Mars have been more complex and dynamic than had previously been considered.
3) Analysis of the Mars atmosphere by the Sample Analysis at Mars (SAM) instrument. This showed atmospheric enrichment in the heavy isotopes of argon and of carbon in carbon dioxide; these results support theories of atmospheric loss on Mars and confirm connection to Mars of gases in Martian meteorites, where the measured Ar-40/Ar-36 ratio is 7 times more enriched in Ar-40 than on Earth.
4) Acquisition of the first X-ray diffraction pattern of minerals from another planet, using the Chemistry and Mineralogy (CheMin) instrument. This information allowed identification of a variety of minerals in the sand scooped at a site called Rocknest (Fig. 3).

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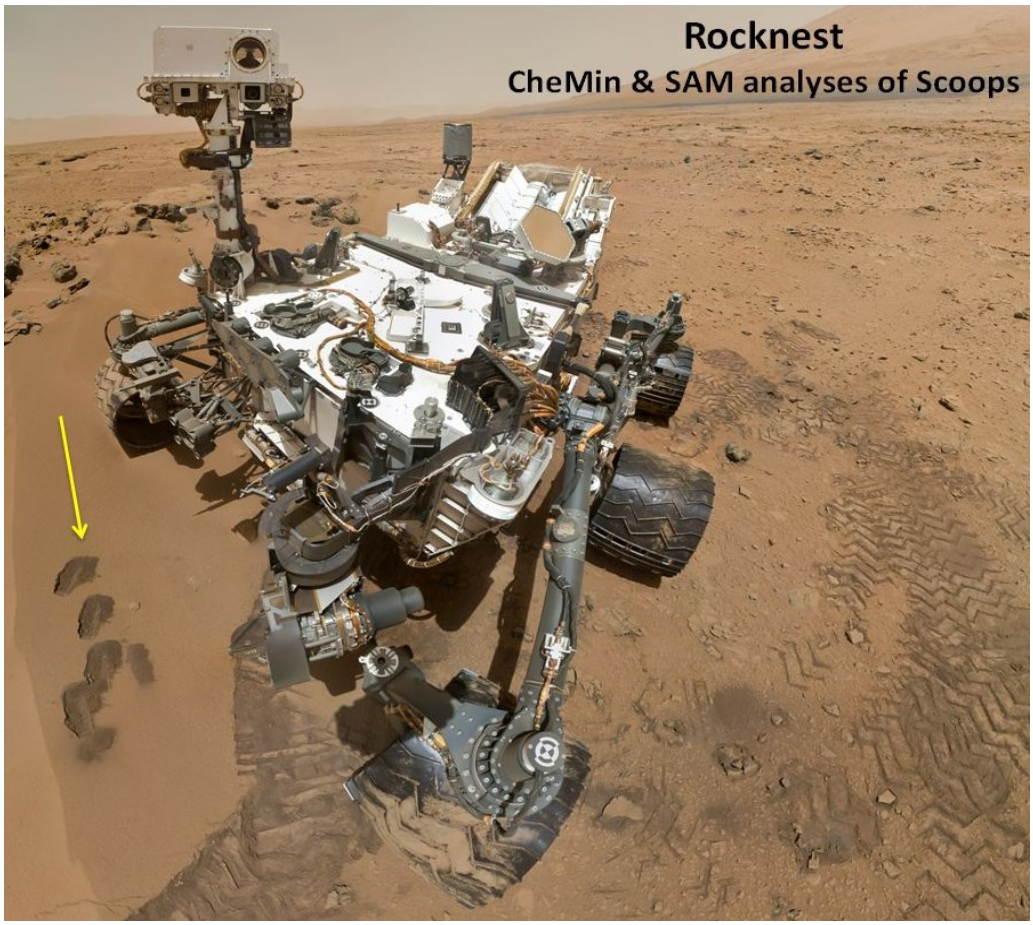

Fig. 3. Self-Portrait of Curiosity taken by Mars Hand Lens Imager (MAHLI) on Curiosity at Rocknest Site where scoop first used for CheMin and SAM analyses. Arrow points to scoop sites. Image is a mosaic of 55 individual MAHLI images. Image Credit, Malin Space Science Systems.

Cover Story

(Continued from page 7)

What is Curiosity's mission and mission duration?

The primary mission duration is two years. The main objective of the mission is to assess Gale crater's past habitability. That means we are evaluating the potential of regions in Gale to have supported life. While we are considering an array of physical, chemical, and geological parameters, major variables include long-lived water as well as the potential for concentrating and preserving organic materials. Our main objective is the 5.5 km mound of sediments in the center of the crater. That mound, officially Aeolis Mons, is unofficially called Mt. Sharp. There is a canyon that goes up Mt. Sharp (Fig. 4) and we will likely be traversing that canyon, looking at rocks in the canyon walls (just as one can do in the Grand Canyon of the United States). The rocks in the lower part of the mound are thought to have formed about 3.6 to 3.8 billion years ago.

For comparison, on Earth, we know that microbial life was abundant and diverse by 3.5 billion years ago (from morphological and geochemical fossils that are preserved in ancient sedimentary rocks). Because of that abundance and diversity, it is reasonable to assume that microbial life was present on Earth before 3.5 billion years ago. Many think that the early histories of Mars and Earth were similar and so it makes sense to consider the possibility that microbial life may have been present on early Mars, as well. Curiosity will be able to analyze sediments in sequence, starting with some of the oldest in Gale. And then, we will be able to "read" the history of the crater in changes in the rock types as we proceed up the canyon to investigate the progressively younger sediments, higher in the mound. In this way, we will learn about the geologic history that spans the change from the early, relatively wet period on Mars to the later, drier and colder time.

Who else in Houston works on Curiosity?

Eleven people in the Clear Lake area work on Curiosity. Of those, ten people work on MSL at Johnson Space Center, in the Astromaterials Research and Exploration

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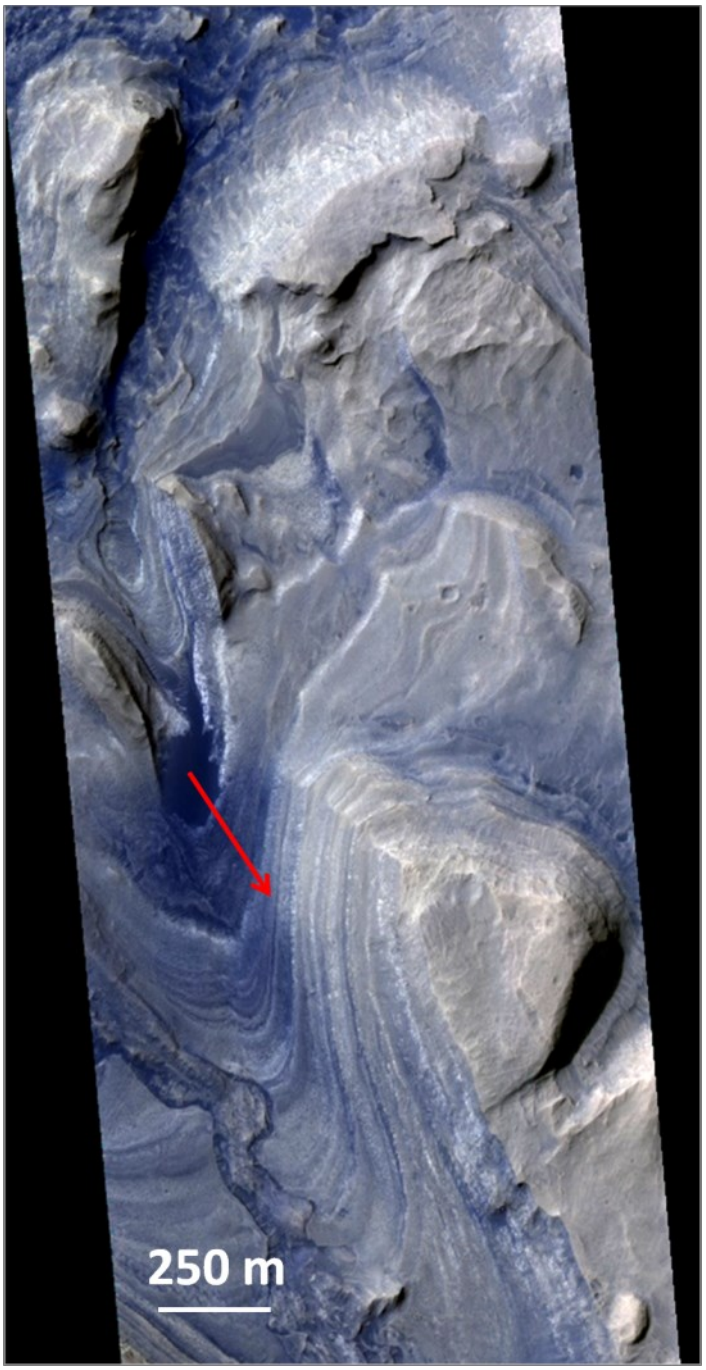

Figure 4. HiRISE image PSP_009149_1750_COLOR, showing the canyon in the mound of sediments at Mt. Sharp that Curiosity will traverse. Red arrow indicates stratified sediment layers in the canyon walls. North is up. Image credit: NASA/JPL/ University of Arizona.

(Continued from page 8)

Science (ARES) Directorate. This group includes two Participating Scientists, myself and Dr. Paul Niles; Dr. Douglas Ming, who acts as a Chairman of the MSL Science Operations Working Group and is also a Co-Investigator (Co-I) on CheMin and SAM; Dr. Richard Morris, a Co-I on CheMin and SAM; Dr. John Jones, a Co-I on SAM; Mr. Trevor Graff, who provides data analysis for CheMin; Dr. Brad Sutter, a collaborator on SAM; and Ms. Cherie Achilles who provides Payload Upload and Payload Download support. In addition we have two Post-Doctoral Associates in ARES who are MSL instrument collaborators, Dr. Elizabeth Rampe for CheMin and Dr. Doug Archer for SAM. From the Lunar and Planetary Institute, Dr. Allan Treiman serves as an MSL Long Term Planner and Co-I on CheMin.

What is expected of Curiosity in the coming months?

Curiosity has just used the drill for the first time. We will take that drilled sediment and begin to analyze it in both the CheMin and the SAM instruments. We anticipate that these analyses will provide information regarding the mineralogical composition of the sediments at YKB as well as potential inclusion of organic compounds, light elements, and isotopic tracers that can add insight into our assessment of the history and habitability of this important part of Mars. When those analyses are completed, Curiosity will turn around and begin the long trip to Mt. Sharp (Fig. 5). It is expected that the trip could take 6 or more months. But once there, Curiosity will traverse up a canyon like that shown in Fig. 4 to evaluate strata of rocks that are exposed in the canyon walls. Scientists will use all the data to select best areas for potential biosignature preservation, and samples from those areas will be analyzed with the full

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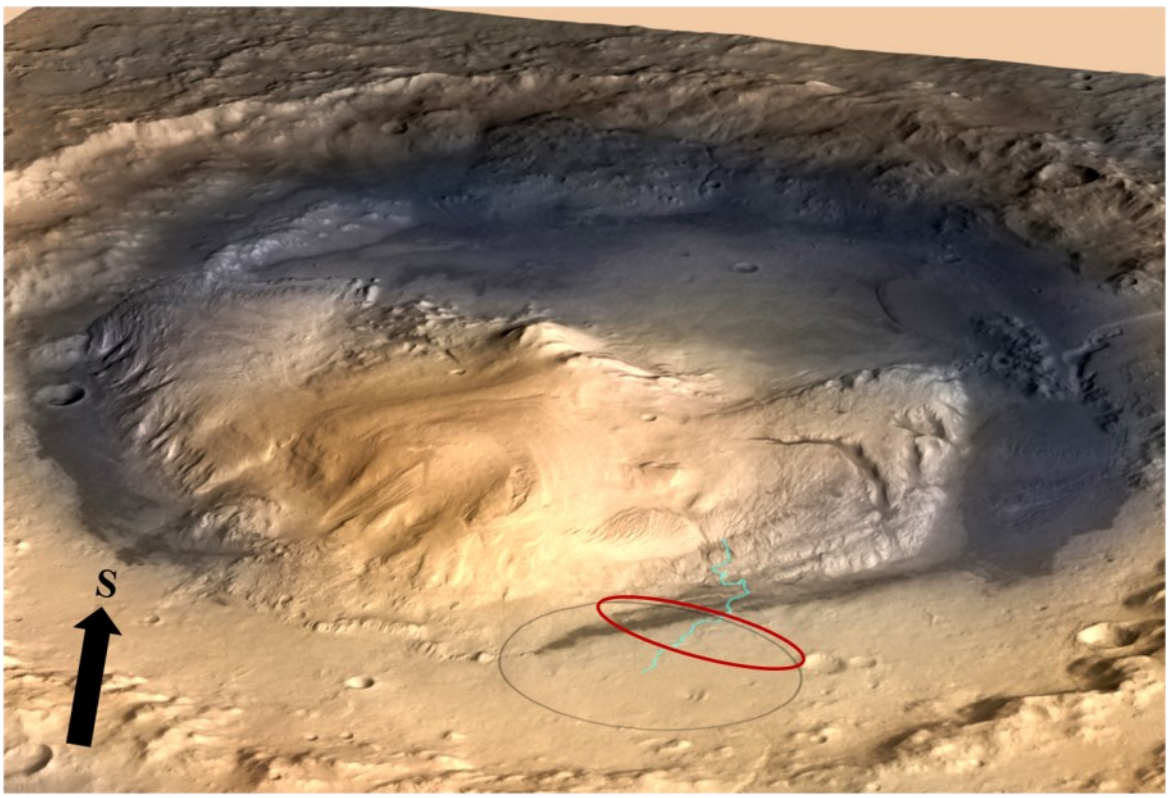

Fig. 5. Oblique view of Gale Crater from a combination of elevation from the High Resolution Stereo Camera on the European Space Agency's Mars Express orbiter, image data from the Context Camera on NASA's Mars Reconnaissance Orbiter, and color information from Viking Orbiter image data. Final landing ellipse, red oval. Earlier landing ellipse, black oval. Green line is approximate route to canyon in Mt. Sharp. Image credit: NASA/JPL-Caltech/ESA/DLR/FU Berlin/MSSS.

Cover Story

(Continued from page 9)

suite of instruments on board (Fig. 6). The rover will additionally look at seasonal variations in atmospheric composition and radiation, in preparation for future exploration.

What do you hope to find on Mars? Lake sediments?

Lake sediments, of course, would be very exciting. But anything that gives us more concrete information about the early history of Mars will be fascinating. Some think that there were abundant lakes on early Mars and some even think there might have been an early ocean in the northern Martian lowlands (see cover image). So data from the MSL mission may provide more insight into this early part of Martian history.

In this regard, Gale crater is a terrific site to be exploring. While the sediments in the upper part of the central mound are thought to have been deposited in a more recent, colder and drier period on Mars, the sediments in the lower part of the mound are thought to have been deposited in the earlier time that was wetter. That early time could have been the most habitable period on Mars. Moreover, because those lower mound strata are buried beneath a 5.5 km high pile of sediments, those strata will have been compacted by the weight of the overlying rock column. That compaction should help to minimize exposure to processes of oxidation on the surface of Mars, and as a result, the preservation potential for organics in these compacted sediments may be enhanced. In addition, Gale sits on the dichotomy that separates the southern highlands from the northern lowlands. That location could have received runoff from surface rivers that might have existed south of Gale and, of course, if there were an early ocean, Gale might have seen some influence of that because of its position on the dichotomy. Finally, the accessible canyon that cuts the mound will provide an unprecedented opportunity to sample the stratified sediments exposed in the canyon walls, allowing investigation of the deposits that span the wet to dry transition on Mars.

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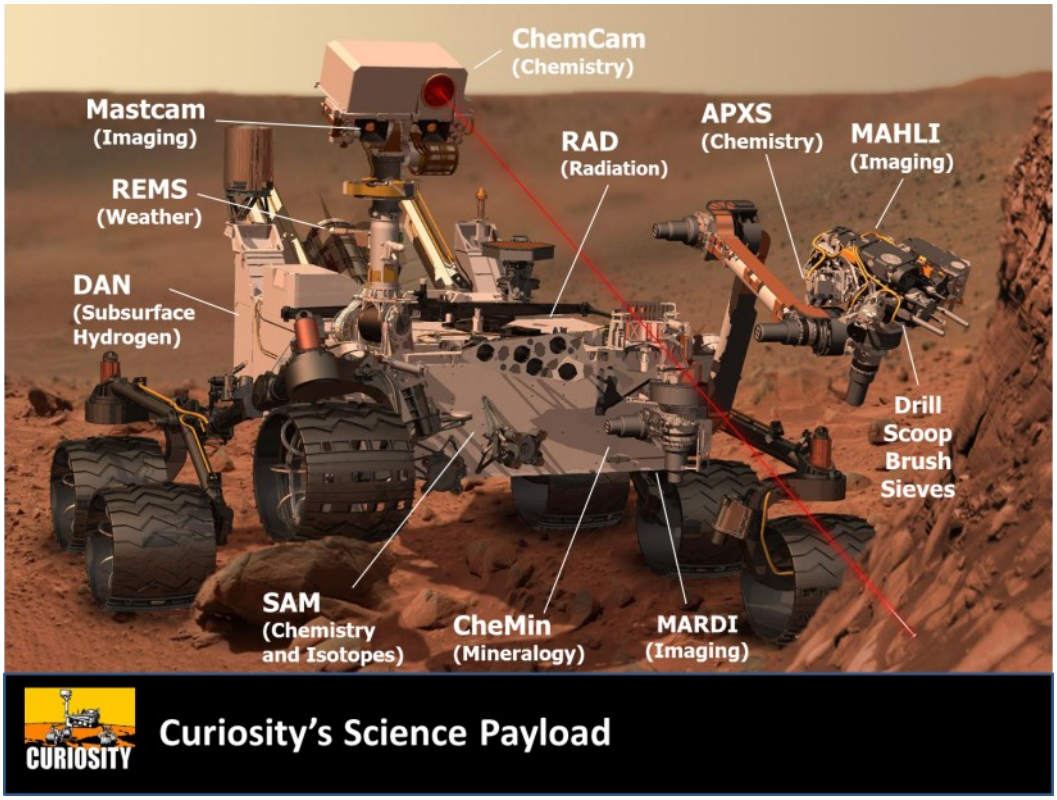

Fig. 6. Curiosity Rover, showing full suite of scientific instruments. For scale, Curiosity is often compared to a Mini Cooper. Curiosity is about twice as long and five times as heavy as each of the previous two rovers on Mars, Opportunity and Spirit. Image credit: NASA/JPL.

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Cover Story

The rover is currently at YKB, the part of the high thermal inertia unit that is distal to the alluvial fan shown in Fig. 2. The sediments in YKB are diverse and unlike anything we saw on the way there from the landing site. The YKB sediments show polygonal fractures, veins of white material that appear to be a calcium sulfate mineral, and potential evidence for fluid interaction with the rocks (Figs. 7 and 8). This is the site where

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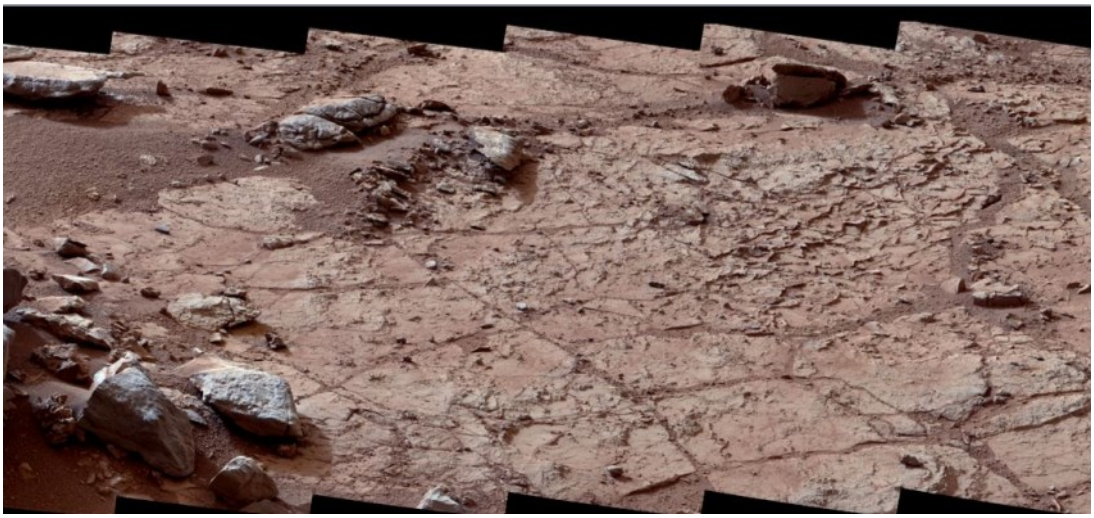

Fig. 7. Sediments at Yellowknife Bay (YKB). Mastcam image credit: Malin Space Science Systems.

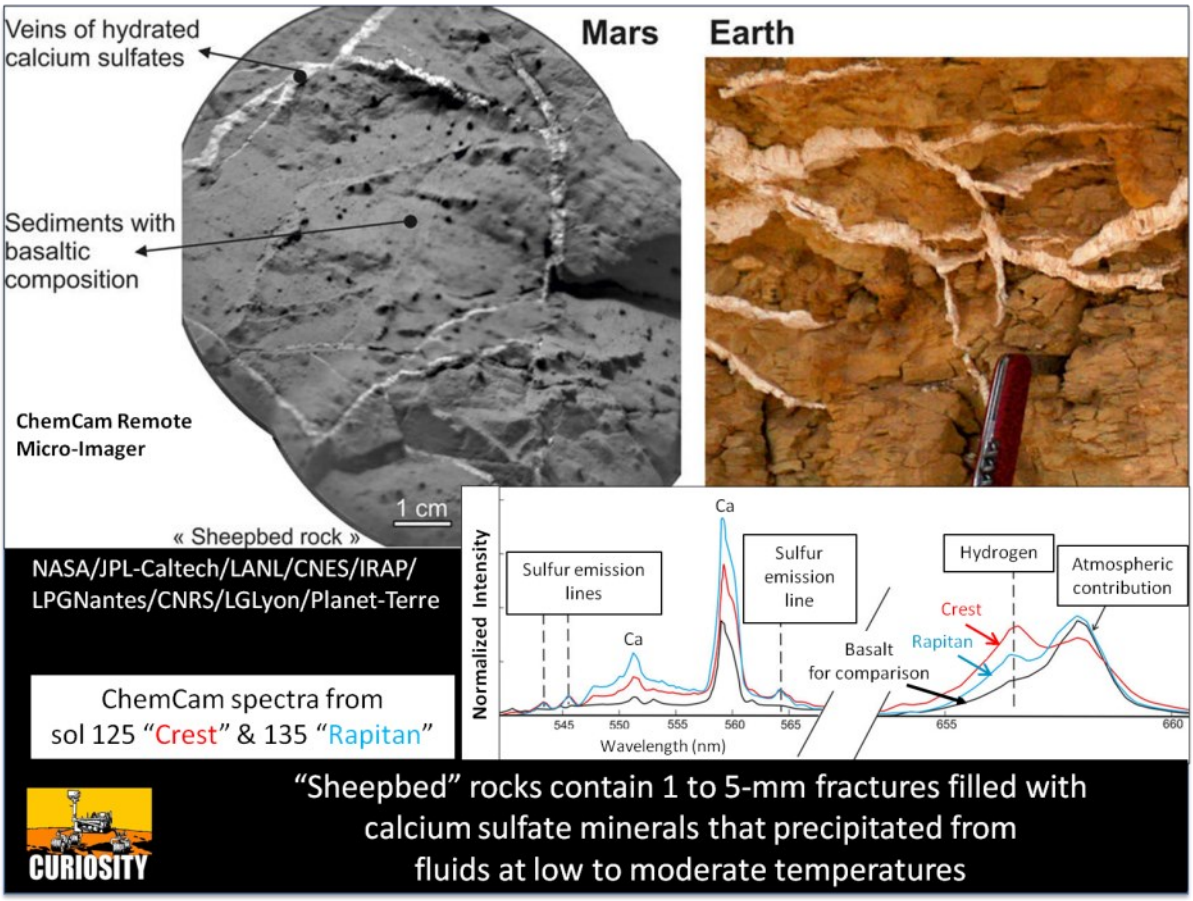

Fig. 8. Veins of hydrated calcium sulfates in sediments at Yellowknife Bay (YKB). Image credit: NASA/JPL-Caltech/LANL/CNES/IRAP/LPGNantes/CNRS/LGLyon/Planet-Terre.

Cover Story

Fig. 9. Curiosity's first sample drilling. *At the center of this image is the hole in a rock called "John Klein" where Curiosity conducted its first sample drilling on Mars. The drilling took place on February 8, 2013, or Sol 182, Curiosity's 182nd Martian day of operations. A preparatory, test shallower hole (the one on the right) was drilled two days earlier, but the deeper hole resulted from the first use of the drill for rock sample collection. The image was obtained by Curiosity's MAHLI camera on Sol 182. The sample-collection hole is 0.63 inch (1.6 centimeters) in diameter and 2.5 inches (6.4 centimeters) deep. The "mini drill" test hole near it is the same diameter, with a depth of 0.8 inch (2 centimeters). Image credit:* ***NASA/JPL-Caltech/MSSS.***

(Continued from page 11)

we just used the drill (Fig. 9) and will proceed to use the full capability of the instruments on Curiosity to help us to understand the history of this fascinating part of Mars.

Biography

Dr. Oehler received her Ph.D. from the University of California at Los Angeles (UCLA) and worked for 20+ years in the international petroleum industry as a geologist/geochemist. After that, she began work at NASA, investigating earliest life forms on Earth as well as applying techniques of predictive geology to questions of Mars habitability. This past November, she was awarded the 2012 Distinguished Alumni Award from UCLA. She lives in Houston with her husband, John Oehler, who has recently published his first novel, **Aphrodesia**, to wide acclaim.

Above: Dr. Dorothy Oehler. Image credit: Dr. John Oehler.

Sarah Brightman on ISS

SANDRINE ROLLAND, 3AF MP, TRANSLATED BY DOUGLAS YAZELL, EDITOR

As a musician, I cannot imagine the vast Universe without sound or vibration, but space is so vast and empty!

So I look for a common thread, the universal characteristic to connect with the essence of Music, the one and only universal language linking the material world of the sciences to the spiritual world of Philosophy and Arts: Mathematics.

The philosopher Leibniz, scientist and mathematician, did he not develop a symbolic mathematics reflecting a formal universal language, his "universal characteristic" for the development of all types of rational and aesthetic discourse, which includes musical notes?

This approach soothes me, unable to conceive for a moment that Music can be absent from the Perfection and Harmony that is the Universe, the famous pre-established Harmony of Hilbert, Minkowski and Sommerfeld, a deep order revealed by numbers. Moreover, Harmony, is it not a major component of Music?

This common factor is a key to Leibniz and all of these princes of mathematical thinking at the University of Göttingen, who studied the deepest mysteries of our Universe: Minkowski, Sommerfeld, Hilbert, Klein, Lindemann, Hurwitz, Weyl, Ramanujan, Gödel, Einstein, Heisenberg, Born and many others today.

In Ancient Greece, Music is already imbued with philosophical and mathematical concepts of Plato and Aristotle, themselves inspired by Pythagoras and his respect for the mathematical relationships that govern the Universe. For Pythagoras and his followers, everything is Numbers. Things, including musical sounds, shape the nature of all numbers that are themselves first principles of the whole of Nature. The conclusion of the Pythagoreans is that elements of numbers are those of all that exists: the world is Number and Harmony.

Thus Music has a cosmic dimension just as Astronomy has a musical dimension.

Plato even asserted that Music and Astronomy are "Sister Sciences." Pythagoras, meanwhile, established a parallel between the distances between stars and musical intervals, finding a certain harmonic proportion: between the Earth and the Sun one obtains a Fifth, and an Octave is obtained between the fixed stars and the Earth.

As for the Celestial Sphere above us, it was the Nine Muses.

The legacy of this thinking is very present in some 20th century composers such as Iannis Xenakis, composer, architect and engineer. In 1954, he created Metastasis, the first music entirely derived from mathematical rules and procedures. His objective was to put into practice a direct relationship between Music and Space Architecture. Probabilities are calculated entirely, using explicit rules.

Consider also the Artist's own Inspiration: was not Mozart inspired by the transcendent characteristic of our Universe to have attained such Perfection in creation, perfect Harmony? A deeply personal conviction has always been there at the core of my being, telling me that Music is part of the essence of this vast, unique and perfect Universe.

In 2015, for the first time in History, a professional opera singer, Englishwoman Sarah Brightman, will embark for the International Space Station (ISS) for what she calls, "the greatest adventure imaginable." For this musician, no doubt in search of Harmony of any kind, it will be an opportunity not only to record her singing from the venue of Space, but to be first and foremost in the heart of the unification of Science and Art.

Sources: The Mind of God, by Igor and Grichka Bogdanov- Wikipedia- musical encyclopedias

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Above: Sarah Brightman, Macy's Thanksgiving Day Parade, 2007. Image credit: Wikipedia.

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Profile of Dominique Teyssier

DOMINIQUE TEYSSIER AND JEAN-LUC OTAL, MEMBER OF THE SPACE TOURISM 3AF MP TECHNICAL COMMITTEE

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Dominique Teyssier, Leader of the SME SatSys (SatCom System, Specialized in Satellite Telecommunications for Aircraft) and One of the First French Citizens to Reserve a Ticket to Achieve a "Baptism of Space" Aboard the Spaceship Developed by Virgin Galactic

$200,000 for a few minutes of weightlessness! Even if the sum seems exorbitant to some, there are men who would like to realize their dream, and this has no price according to them! Dominique Teyssier is one of them. Leading SatSys, SME with ten employees and realizing an annual turnover of 500,000 euros, he did not hesitate to open his wallet for this opportunity. And when others accuse him of wasting his money, well, he once replied, "It seems to me that in France, money has always been a taboo subject. Many people buy expensive cars, boats, country houses for amounts far higher. I could do the same but that does not interest me. I am more challenged by 'being' than by 'having.' This is why I chose to participate in this adventure."

Dominique Teyssier's Childhood Dream

"When I was eight, I remember a movie showing only once at our only movie theater, a single screening, in our tiny village in Ardèche (France) where my father was a schoolteacher. The movie was, 'The Day the Earth Stood Still,' directed by Robert Wise. We were not many, maybe 10 or 15 students [in the theater]. It was the first time I went to the movies. This film is etched in my memory and even then made me feel like doing at least what Gagarin had done in 1961 [being the first person in space and the first person to orbit Earth]," says Dominique Teyssier. In

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Right: Image of Dominique Teyssier, Courtesy of 3AF MP.

Right: Image source for map, flag and coat of arms: Wikipedia. Map of the Ardèche "departement" (in red) and the rest of France. Image credit: Marmelad. The flag of the Ardèche "departement" in France. Image credit: user:Spedona. The unofficial coat of arms of the Ardèche "departement" in France. Image credit: Syryatsu.

(Continued from page 14)

1969, he watched, enthralled, the images in black and white of Aldrin walking on the Moon on the television that his father placed outside the village's only shop, a small store that belonged to his grandmother. Memories! Yet when it came time to choose his path, he did not really know what to do for a living. He first began studying physics and chemistry, before entering business school, guided by his desire to work internationally. In the early 1980s, just graduated, he moved to Paris and worked in a travel agency. One foot in travel and soon another foot in aeronautics... In 1991, he earned a private pilot license in France, then the IFR flight rating (IFR, English for Instrument Flight Rules) and a commercial pilot license in Miami. He was lightly touching his finger on his childhood dream of becoming a pilot. But fate decided otherwise. At the time, "Of about 2,000 pilot graduates, half were unemployed." recalls Dominic Teyssier. For two years, despite an economic downturn, he sought a position, a good career job… in vain.

Dominique Teyssier's Chance

"Many children dream of being a pilot, fireman or astronaut. The hardest thing is to realize one's dreams. I have the chance to do it," Dominique Teyssier can say now, sitting at his desk, filled with model airplanes and helicopters. Even though he did not have a career as a pilot, he will be in the shoes of an astronaut one day soon. In 2008 he discovered by chance that tickets were available for purchase to board the spaceship of the billionaire Chairman and CEO of The Virgin Group, Richard Branson. He participated in many phone calls with Virgin in England, then with World Travelers, the travel agency that markets such space travel in France, but without success. He remained undeterred. Three months later he received a call from Jean-Luc Wibaux, consultant for World Travelers. "Just checking to ensure you are still interested…" In September 2011, his dream moved closer to reality when he received a letter from Virgin Galactic telling him that he was booked on SpaceShipTwo (the rocket airplane glider to be launched [dropped for an air launch at high altitude] by the mother ship, the airplane White Knight Two) and he received a giant book full of images of his future journey. "Right now, my relatives do not realize what I will be doing, but my staff is aware and smiling. As for my clients who are aware, they find it good. Some are jealous." says Dominique Teyssier. For him it is "…the culmination, the realization of the efforts made since 2001, when I worked tirelessly to support my products and my company." Today, he looks forward to the

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Left: Virgin Galactic mother ship White Knight Two. Image credit: D. Miller. Image source: Wikipedia.

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I am more challenged by "being" than by "having."

Dominique Teyssier

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moment when he can, "… unbuckle my seat belt and experience weightlessness, floating in space, closer to the stars, enjoying the beauty of Earth from above."

Before becoming a space traveler, Dominique Teyssier recalled, "In 1990, I left my position as marketing manager in a company that sold spare parts for aircraft to create my own company, Aerosoft. For three or four years, I made it work with a three-person team, creating flight planning software. Then I worked in the trading of aircraft (business jets and helicopters mostly) until 1999, when I was hired by a startup in Toulouse, France, Easy Flying. This company specialized in flight planning on the internet, very innovative at the time. The adventure lasted until 2001, when the internet bubble burst. While we were the first software to market, investors [did not come our way to support us and make us a success]. The fall was very rapid. Having a hard time finding work, I decided to create SatSys in 2001, a company specializing in satellite telecommunications for aircraft.

"At SatSys, we design and manufacture satellite communication products for aeronautical satellite systems, mostly for government aircraft and helicopters for telephony and internet access, software tracking system (which tracks the 3D trajectory of an aircraft) or cameras that take pictures and video for surveillance helicopters. I sell my products to the majority of manufacturers of aircraft and helicopters.

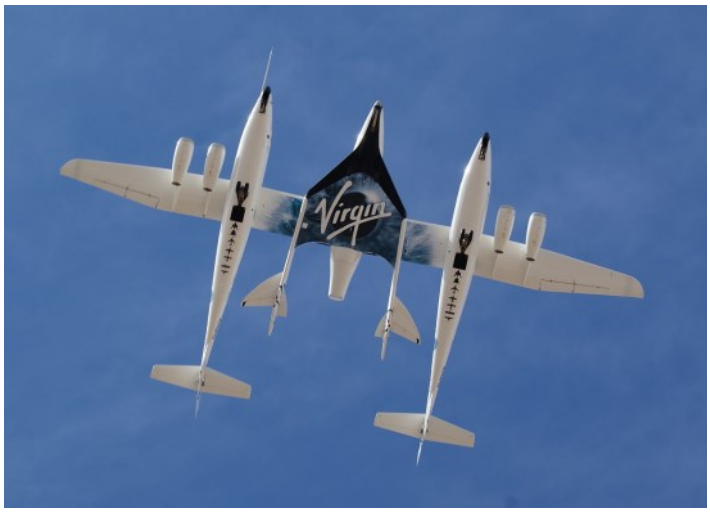
"When I created SatSys, I had to invest in everything by myself: technical studies, the first test prototype flight, etc. I experienced very difficult times. It took four years to get the first real contract, one with Eurocopter in 2005.

"Today, the goal of SatSys is to install our products on anything that flies. If our competitors are large companies such as Alcatel, Cassidian and Thales, this does not prevent us from doing well in the marketplace, because, like all small companies, we are able to produce 'sheep with five legs' [unusual products] for our customers.

"To date, our products are designed in Montréal and manufactured in Toulouse, and we operate commercially in Europe, Turkey, Canada and the United Arab Emirates, which together account for 80% of our turnover.

"Efforts have happily paid off. Today, our equipment is present on everything from very small aircraft such as unmanned aerial vehicles (UAVs) to the Boeing 747, and why not one day on White Knight Two and SpaceShipTwo?"

Right: SpaceShipOne test pilot Mike Melvill after the launch in pursuit of the Ansari X Prize on September 29, 2004. Photo taken by RenegadeAven during Civil Air Patrol duties. Date: 29 September 2004. Image source: Wikipedia. Image credit: Renegadeaven at en.wikipedia.



Right: White Knight Two and SpaceShipTwo directly overhead during a flyby at Spaceport America. The Virgin Galactic logo is clearly visible on the underside of SS2. Date: 22 October 2010, 13:52:07. Image source: Wikipedia. Image credit: Jeff Foust.

A Visit to Pierre-Paul Riquet Saint-Orens High School (Haute-Garonne, France)

3AF MP

PHILIPPE MAIRET, 3AF MP, TRANSLATED BY DOUGLAS YAZELL, EDITOR

December 18, 2012

The Lycée Pierre-Paul Riquet (LPPR) is a modern high school in a dynamic environment. Opened in 1991, it belongs to the younger generation of high schools in Toulouse and its suburbs. It accommodates 1,640 students. It is located in the commune of Saint-Orens de Gameville (also known as Saint-Orens), where the borders of greater Toulouse and the Lauragais region meet. Conveniently located, it offers to students from a wide geographical area diverse training on many general programs. A center of scientific and technological competence, this French high school develops lessons for different levels of diploma: general and technological baccalauréat (The "bac" is the test required at the end of a high school career.), BTS, and preparatory classes for the "grandes écoles" (France's most prestigious universities) of the sciences and technologies of the Engineer. Known as the Space High School (Lycée de l'Espace), located near the "Aerospace Valley" schools of engineering, the French National Center for Space Studies (CNES), Rangueil campus in particular, this high school is at the heart of innovations that will shape research and future technologies in the Midi Pyrénées region of France. (That was from the LPPR web site.)

In December of 2012, Mr Jean-Louis Fréson, former Director of the Superior Institute of Aeronautics and Space (ISAE) Ensica, working for the Institute of Engineers and Scientists of France (IESF) and the Regional Union of Engineers and Scientists Midi-Pyrénées (URISMIP), welcomed us to the lycée. We were a group of three: José Manzano (a retired engineer ENSAM who has experience with two business segments, Civil Engineering and Pharmaceutical Chemistry), Thierry Pardessus (of Ecole Polytechnique, ISAE Supaero, Airbus) and myself. We were visiting to talk to high school freshmen, sophomores and seniors about engineering careers.

I arrived at the school well before 4:00 PM with brochures from the French National Council of Engineers and Scientists (CNISF). On the way, I was asking myself, "What will I say to them?" But I told myself that this is a challenge, and as a working engineer and university graduate, I like a challenge. In spite of a certain shyness related to public speaking I retained from my youth, I told myself, "It is decided!" As planned, "I will tell them about my journey from sixth grade (about age 11) to my first job as an engineer in France."

We met in a multi-use auditorium with Ms. Catherine Mautray of the high school and Mr. Joël Daste of ISAE. Mr. Daste reminded the students that not just communication, but "good communication," was important. Questions from students were allowed and recommended. He stated that engineering careers were not well understood by

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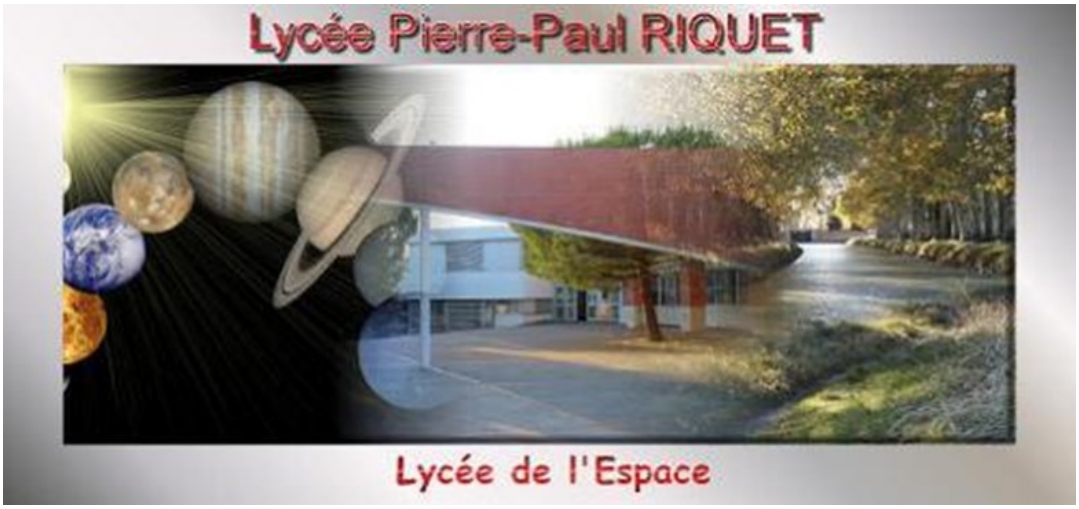

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high school juniors and seniors. Mr. Pardessus mentioned that all three speakers were there to give advice to students.

Mr. Manzano made a presentation about the engineering profession. "What is an engineer?" He explained that an engineer can be a technician, a manager, and even an administrative. I would add that he or she can also be a combination of all three. An engineer may have scientific and technical skills and human qualities. Mr Manzano gave the example of creating a table. This example illustrated some techniques that can be of use to engineers: value analysis, functional analysis, and development of specifications. He also presented a history of the industrial revolution(s) , he told us that fossil fuels are not inexhaustible, he explained that the threshold of 9 billion human beings could be exceeded by 2050, he specified the need for inventing a new industry for the future, and he emphasized the need for engineers in the XXI century. What are the qualifications for this engineering career? We must "be creative, adapt to constraints and external events, be tough, have an attraction for technology and science, have an ability to maintain abstractions, or at least have some of those qualities. Remember, be creative, too! (After all, why not?)"

Following Mr. Manzano, I took the floor and spoke about my experiences. At their age I sought advice from family members, friends, classmates and acquaintances, but also teachers (including teaching teams and advisers). As for the required military service of my day, I traveled abroad as part of Military Cooperation. Since the Lycée Pierre-Paul Riquet is The Space School in France since 2010, I also talked about my first post: Engineer, specialist, "Cockpit Installations" for the European space shuttle project called "Hermes," in charge of tasks including air conditioning, oxygen, and thermal cooling of the avionics. I also outlined some technical specialties characterizing this project (thermal protection using "ceramic tiles," for example, and some preliminary studies on "Backup Systems" (including ejection seats). I also spoke about the "reorientation" of this project, following the Ministerial Conference of the European Space Agency (ESA) in November 1992. I mentioned a recent project, ESA's Advanced Re-Entry Vehicle (ARV, which is not spoken about since the ESA Ministerial Conference in November 2012) and the planned American crewed space vehicles: the capsules named Dragon from Space X and CST-100 from Boeing, and the "Baby Space Shuttle," the Dream Chaser of Sierra Nevada Corporation.

Finally, Mr. Pardessus told us it was important to find a balance between work, family, and friends, both personal and professional. He spoke of "technology," and even "biotechnology." Mr. Manzano reminded us of the importance of Mathematics, Physics, Chemistry and Applied Electronics, and of the areas of Materials and Structures in particular, but he also spoke of nano-machines and nano-technologies. He also addressed the question of Intellectual Property and Patents.

We finished with a question and answer session. I hope the students found the event rewarding. To the organizers, I send a big thank you.

Five Tau Ceti Planets in the Signals, Two in the Habitable Zone

Exoplanets

WES KELLY, TRITON SYSTEMS, LLC

This January the American Astronomical Society held its 221st meeting in Long Beach, CA. Comparable in size, attendance or disciplinary scope to the AIAA Aerospace Sciences conferences held during the same month elsewhere (Dallas/Ft. Worth), interests of the two communities intersect over satellite observatories launched into space requiring close coordination between engineers and astronomers. But what's more, increasing concern in the astronomical community with detection and characterization of "extrasolar" planets gives form, character and specific targets for high aerospace aspirations: travel to planets about other stars. At the least, findings of this nature point to spacecraft missions for direct imaging or atmospheric spectral analysis of extrasolar planets.

For anyone tracking the annual AAS winter meetings, it is clear that extrasolar planet sessions have increased remarkably over the last twenty years; from a few tentative papers to whole sessions (Table 1) on discoveries, detection techniques, assessment of atmospheres, size in comparison to solar system types ("Jupiters," "Neptunes," "Earths...") types of stellar primaries, formation process, habitability….(!) Planet confirmations approach 1000 and thousands of objects too small to be considered suns (e.g., brown dwarfs) add into a wider definition tally.

Which of the season's or the conference's reports or discoveries is most significant? We hesitate to say with so much to examine. Yet in prelude to the 2013 conference, the December 19th San Francisco Chronicle reported, "International astronomers, including a leading planet hunter at UC Santa Cruz, say they have detected five possible planets circling a distant star much like Earth's sun - and that one of those planets is apparently in the famed 'habitable zone' where water could exist on its surface. The

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Above: Wes Kelly (at right) in an image from page 15 of the March and April 2012 issue of Horizons (page 15). At left is James C. McLane III. Image credit: Douglas Yazell.

Table 1. 221st American Astronomical Society Meeting Extrasolar Planet Sessions - January 2013

Session	Title
104	Circumstellar Disks I
109	Extrasolar Planet Detection from Spectroscopy and Micro-lensing
126	ExoPlanet Interiors and Atmospheres
135	Scientific Opportunities for the James Webb Telescope
144	Circumstellar Disks
149	Extrasolar Planets: Detection
158	Stars, Cool Dwarfs, Brown Dwarfs
205	Circumstellar Disks II
220	Circumstellar Disks III
224	Exoplanet Atmospheres
231	Planets and Planetary Systems Identified by Kepler
236	Newton Lacy Pierce Prize: Hot on the Trail of Warm Planets Orbiting Cool M Dwarfs
308	Planetary Systems Orbiting White Dwarfs
315	Transit Selection of Extra Solar Planets
324	Direct Detection of Exoplanets, Faint Companions and Protoplanetary Disks
333	Super Earths, M Dwarfs and Habitability
334	Survey and Catalogs of Extrasolar Planets
336	The Elemental Compositions of Extrasolar Planetesimals from Spectroscopy of Polluted White Dwarfs
343	Extra Solar Planet: Characterization, Theory and Detection
403	Dusty Debris in the Terrestrial Planet Zone II (?)
407	Kepler Exoplanets
424	Planetary Systems Orbiting White Dwarfs and Neutron Stars
435	Extrasolar Planets

Exoplanets

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team led by Mikko Tuomi of the University of Hertfordshire used a new technique to find the planets around the star Tau Ceti using telescopes in Hawaii, Chile, and Australia. The planet that is in the habitable zone is only five times the mass of Earth, they calculate." Subsequent reports debate whether the discovery consists of one habitable planet or two.

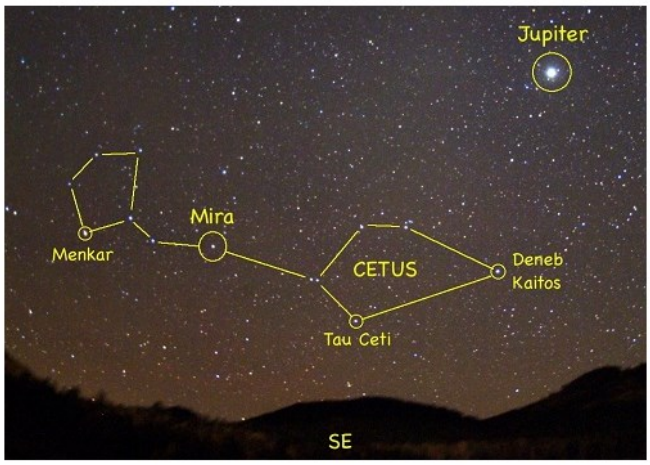

Image: Photograph of the constellation Cetus, with Tau Ceti identified. Credit: Westlake.

Figure 1. τ Ceti in the northern sky defining constellation.

Detection methods for these planets were distinct from the transit method employed by the Kepler observatory, true; but they are still based on Doppler radial velocity measurements, variations of absorption lines in the visual spectrum of the primary star, like the original 1990s planet discoveries by pioneers Mayor, Marcy and Butler. What is different now is that Bayesian statistical analyses are being used, combining spectrographic measurements from several observatories: at Hawaii, Chile and Australia. If you have seen the term "rolling average" in a stock performance report, then there's a big clue to what's new in extrasolar planet search software and technology.

As Figure 1 shows, Tau Ceti is a defining member of the constellation Cetus the Whale visible in the northern hemisphere. If the constellation can be discerned by an observer, then this specific nearby star can be pointed to as well as a possible to planets similar to the earth, worthy of further study or exploration.

It is unavoidable to quote extensively from the report of Tuomi et al., posted on line at a Hertfordshire University site. To start, the authors provide the defining parameters for Tau Ceti (Table 2) on which their observations are based. And in conclusion they provide similar tables for five planets, the last two of which are of most immediate concern due to their similarity to earth in thermal surroundings, dimensions or mass (Table 3).

Beside parameters derived for the five possible planets, Table 3 with its "sigma" measures give us an indication of the radial velocity sensitivities of the three observatory instruments involved in the study: the HIRES, AAPS and HARPS spectrographs located respectively at three separate observatories, the Keck (Hawaii), the Anglo-Australian (Australia near Sydney) and the European (ESO) in Chile.

HIRES is a grating echelle spectrograph capable of operating between 0.3 and 1.0 microns (UV to IR) attached to the Keck Observatory on Mauna Kea on the island of Hawaii.

The AAPS is the Anglo-Australian Planetary Search program undertaken with the Australian Astronomical Observatory. The AAPS exploits the high stability of what was the University College of London

(Continued on page 21)

Table 2. Estimated Stellar Properties of Tau Ceti or HD 10700.

Parameter	Units	Value	Notes
Spectral Type		G8.5 V	
log *R'*HK		-4.995	Magnitude
π	[milli-arcsecs]	273.96 ±0.17	Parsec measure
L_{star}	[L_0]	0.488 ±0.010	Luminosity
R_{star}	[R_0]	0.793 ±0.004	Stellar Radius
Mstar	[M_0]	0.783 ±0.012	Stellar Mass
T_{eff}	[^{o} Kelvin]	5344 ±50	Effective Temperature
[Fe/H]	[vs. Solar]	-0.55 ±0.05	Metallicity
Age	[Giga-years]	5.8	
v sin i	[kms^{-1}]	0.90	Stellar Radial Velocity - Nominal
P_{rot}	[days]	34	Stellar Rotational Period

Table-3 System Summary – Nominal Orbital Solution of HD 10700 Radial Velocities

	Tau Ceti	b	c	d	e	f
Minimum Mass *	**(Earths)**	**2.0**	**3.1**	**3.6**	**4.3**	**6.6**
Semi-Major Axis	**(AUs)**	**.105**	**.195**	**.374**	**.552**	**1.35**
Period	**(Days)**	**13.95**	**35.36**	**94.11**	**168.1**	**642**
Eccentricity	**-**	**0.16**	**0.03**	**0.08**	**0.05**	**0.03**
ω	**(radians)**	**1.5**	**3.0**	**4.0**	**5.5**	**3.9**
t_0 **	**(days)**	**4.17**	**20.62**	**2.31**	**37.42**	**168.49**
M_0	**(radians)**	**2.6**	**3.2**	**5.8**	**0.5**	**1.6**
K	**(m/sec)**	**0.64**	**0.75**	**0.59**	**0.58**	**0.58**
Instrument Sensitivities						
$\sigma_{J,1}$ (HIRES)	**(m/sec)**	**2.14**				
$\sigma_{J,2}$ (AAPS)	**(m/sec)**	**2.13**				
$\sigma_{J,3}$ (HARPS)	**(m/sec)**	**1.06**				

* **M_{PL} sin i (inclination to perpendicular to line of sight)**
** **ω** - argument of periastron, **t_0** - time of periastron, **M_0** - Mean Anomaly,

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Echelle Spectrograph (UCLES) to obtain the few meter per second measurement precision in radial (line-of-sight) velocities of stars, i.e., the necessary minimum to detect the reflex stellar Doppler motion induced by the presence of a terrestrial mass planet.

The HARPS high accuracy radial velocity planet searcher is attached to the 3.6 meter European Space Observatory, located in the high deserts at La Silla, Chile. Since October of 2012, it has built to a capability of detecting a 0.96 meter second variation in visible spectral lines, perhaps currently the best such instrument on earth or in space.

Rolling Averages and Spectral Lines

As reported in an earlier Horizons, radial velocity measurement detection of planets is hindered by background noise from both instrumentation and stellar targets. Tuomi and the rest of the team, in targeting Tau Ceti were not so much intent on discovering planets as they were in isolating and modeling the jitter effects surrounding the planetary search process. Sifting through the three observatories cumulative measurements and comparing them, their statistical processing did much to clear away the noise. If polluting sonic frequencies can be erased by countering noise 180 degrees out of phase, then much the same can be done with light noise. In examining the sources of noise, it was necessary as well to adjust the filters with time for effects such as natural stellar overtones on other cycles. But when all of these measures were taken, the researchers were startled to find remaining Keplerian motions that had not been identified before.

Much of the argument in behalf of the detections is based on Bayesian statistics and "posterior distribution" parameters. As others have observed, some of these techniques have been used to significant effect by mathematicians and physicists working on Wall Street, the tools of the trade for "quants." For a non-statistician, such as this reporter, "a priori" sounds more familiar than probability measures "posterior;" and the qualifier "Bayesian" often leaves one with dread. So, what can be said about this? Perhaps a simple situation comparison helps.

I have two coins with heads and tails, and then also I have two keys: one to an office building and then one to my office within. The keys are each difficult to distinguish from each other, especially in the dark. But the point is that likelihood of calling heads and tails with the two coins will have a different distribution than the likelihood of selecting the second key to the office door. This is because there are different underlying assumptions. Even if the wrong key is selected for the office building, the likelihood of selecting the right key for the second door is very high – unless one misplaces the keys all over again in the hallway dark.

Now what if the keys are not held in one's right and left hand, eliminating uncertainty about which key was first used? And then what happens if the keys are dropped and the background light is adjusted down to a threshold where murk affects things much the same as full darkness? The certainty about

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Exoplanets

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which key is correct for the second lock is altered accordingly.

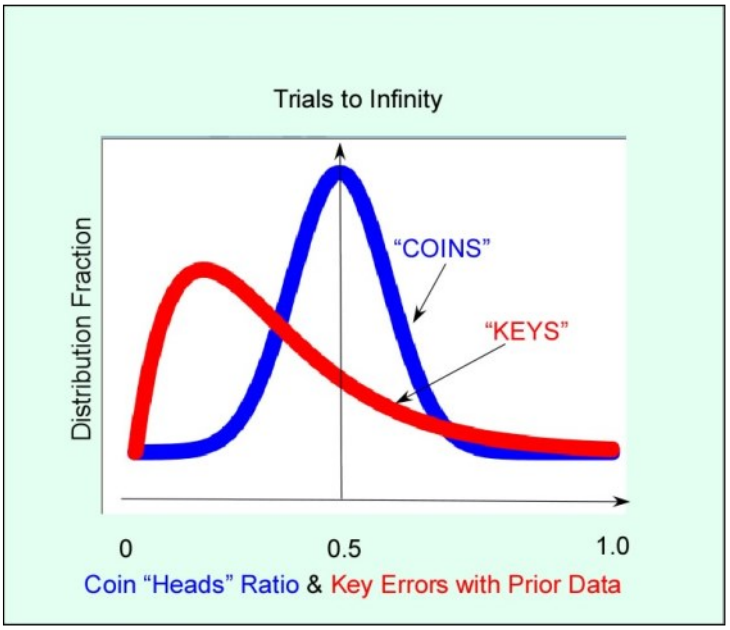


Figure 2. Altered distribution of results based on knowledge of keys vs. coins.

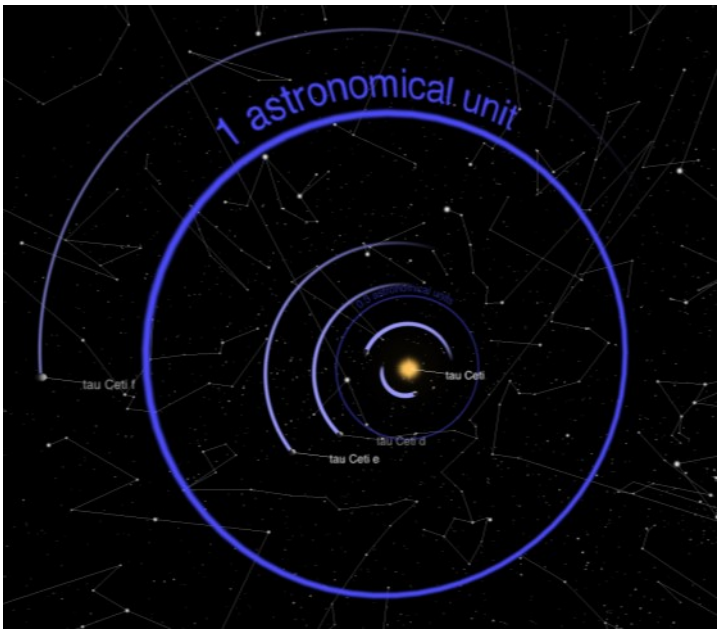


Figure 3. τ Ceti system of planets derived from radial velocity measurements showing that between planets "e" and "f" there exists a large gap.

And now suppose we have a hundred coins that we flip and a hundred embedded door and safe locks that generate heads or tails and yes or no decisions respectively. The statistics of the hundred coins with each successive trial will generate a distribution of results that will spread symmetrically about a 50-50 distribution of heads and tails. But the replay of the lock and key distribution will alter from these statistics as knowledge assumptions about the successive lock and key operations are changed, as Figure 2 suggests. Now suppose that beside a sequence of doors and safes to lock in dim light, one is also wearing night goggles sensitive to light within certain wavelengths and the system experiences jitter…

The point here is that knowledge about seemingly random processes surrounding stars and instrumentation is not entirely without clues to their nature – and that these processes can be modeled enough to clear away much fog.

Yet what is striking about the reported result is that if the values of K in Table 3 are considered as velocity magnitudes for the planet induced cyclic motions of Tau Ceti, all the values are well below the nominal sensitivities of the three instrument detection systems. Curious about Bayesian statistics and Markov chains now?

Planets as a Function of Inclination – And Then Density

Paradoxically, the best angle to get a reading on the orbital velocities of Saturn's rings is when they are hardly visible at all – when they are observed on edge. Then again, if the rings were observed from a surface normal, then no normal radial velocities could be obtained from their light. Yet although the Tau Ceti planets and their orbital plane might be invisible, the stellar spectral line shifts that they cause can be observed even if the line of sight to the star is parallel to the plane. In that case, with each orbit there would be two points at which non-radial velocities would be reduced to zero with each circular orbit. Using the convention of "inclination" adopted by astronomers for studying binary stars, zero inclination is observation of the system perpendicular to its plane. Hence, inclination of 90 degrees would be observation "edge on." If this can be demonstrated by transit events (such as observed with the Kepler observatory), then there is no uncertainty in mass due to inclination uncertainty and mass is well pinned down.

But if inclination is unknown and a mass is derived from the apparent Doppler shifts of the star due to radial velocity variations, actual planetary mass would vary as a function $M = M_0/\cos(i)$, where i is an inclination between 0 and 90°. For "line of sight offsets" of 45 to 60°, the mass increases by 40 and 100%, of course, as Figure 4 indicates. Consequently, if a nearly earth like planet has a density much like Earth's (~5 gm/cm3), then we could also derive changes in diameter with mass as well as differences in surface gravity. Venus, Earth and Mercury have similar densities; but yet the Moon and Mars have densities closer to 3/5 that of these terrestrial planets. Do we know whether these planets would have either density? No, not yet, but we can show

(Continued on page 23)

(Continued from page 22)

the effect of reduced density on radius and surface gravity (Figs. 5 and 6). Reasons for reduced density might include less iron relative to silicon – or more water condensation in formation. But depending on the surface albedo, greenhouse effects and location within the presumed habitable zone, low density could solve the high gravity problem in the event of human visitation, but there would remain an issue of whether the resulting planets would resemble Neptune or Venus more than the Earth with thick blankets of atmosphere merging into bottomless seas.

Habitability

Of course, we assume for starters that the Earth is inhabitable, but comparative interstellar planetology requires examining many stellar and planetary characteristics to mount a case for habitability elsewhere – and the data is not necessarily all there. To start with, thermal flux from Tau Ceti or another star must be calibrated with the sun before considering how that thermal flux is absorbed or reflected back into space by a planet we will eventually have to describe as well. Considering that total flux from a stellar spherical surface remains constant between its surface radius ($4 \pi R_{SURF}^2$) and the orbital radius of the planet, then we know that effective temperatures in space decrease with distance. That is, luminosity is constant.

$$L^* = \sigma\, 4\, \pi\, R_{SURF}^2\, T_{EFF}^4 = \sigma\, 4\, \pi R_{PL}^2\, T(R_{PL})^4$$

Allowing for some round-off or measurement uncertainties, and starting with the Earth-Sun relationship, the 700,000 km radius sun with a 5800° Kelvin surface temperature (T_{EFF}) would diffuse to a temperature of about 400 ° K at Earth's orbital radius of 1 AU (149.95 million km).

$$T(R_{PL}) = (R_{PL}/R_{SURF})^{0.5}\, T_{EFF} = 396.7^{o}K$$

Since Mars (R=1.52) and Venus (R=.67 AU) might provide rough bounds for habitability if their surface and atmospheric reflectances were tuned rather well to sustain near room temperature (300° K) conditions in the temperate zones, as with the Earth, then control volume temperatures at those regions would be rough bounds for the solar system's habitability belt. The cooler, smaller and therefore less luminous (0.488) Tau

(Continued on page 24)

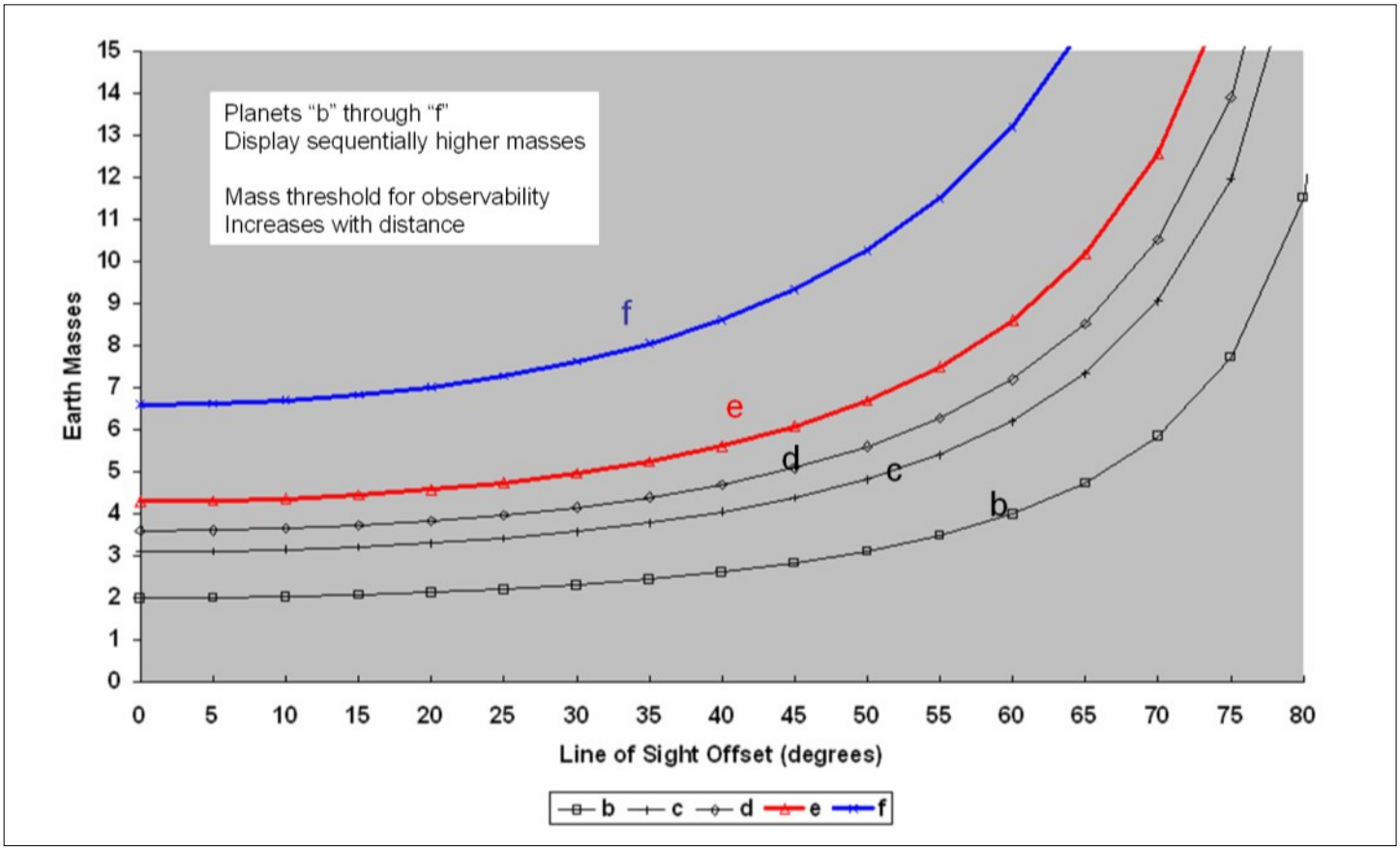


Figure 4. Tau Ceti planets b through f – mass as a function of inclination from line of sight.

Exoplanets

(Continued from page 23)

Ceti produces the same temperature at a radius of about 0.698 AU. The "Venus-Mars" bounds can be redrawn for Tau Ceti accordingly as 0.48 and 1.06 AU the limits of habitability.

So, do we have any possibility of winners? The planets "e" and "f" are located at orbital distances (semimajor axes) of 0.552 and 1.35 respectively (illustrated in Fig. 3). By the rules described so far, "e" would qualify as a habitable planet and "f" at first glance would be considered more hostile than Mars. And yet the prospects in our own solar system for present day "habitability" for Mars are far greater than that of Venus, though perhaps billions of years back, water and earth-like temperatures or atmospheric pressures might once have prevailed on both.

Ignoring the layered equilibrium temperatures of a thick cloud cover or other elaborate heat transport mechanisms, the planetary surface reflectance (inverse: albedo) would give us an estimate of how much of that stellar flux is radiated back into space. Greenhouse effects near the outer limit would be more supportive for the case of habitability there.

Then there might still be an as yet undetected planet between "e" and "f" with a mass more near that of Earth's. Our calculations of spheres of influence with increase of planetary mass do not rule this out. Examining spacing (.105, .195, .374, .552, 1.35 AUs), mass (2.6, 3.0, 5.8, 4.3, 6.6) and period (13.95, 35.36, 94.11, 168.12, 642 days), there is no obvious reason there should not be a planet or two between detected "e" and "f." And habitable or not, observing the other planets from that point in the mid habitable zone would be spectacular in comparison to events in our system's ecliptic plane.

Wrap Up

Just last August this writer had the occasion to see the Discovery Channel video Alien Planet which described a visit to a nearby extrasolar planet by a future robotic spacecraft. Many of the features of the story seemed to suggest they were describing Tau Ceti, or a similar nearby star.

I believe the destination star was fictional. But had the writers and contributing scientists known!

References and Figure 6

(Continued on page 25)

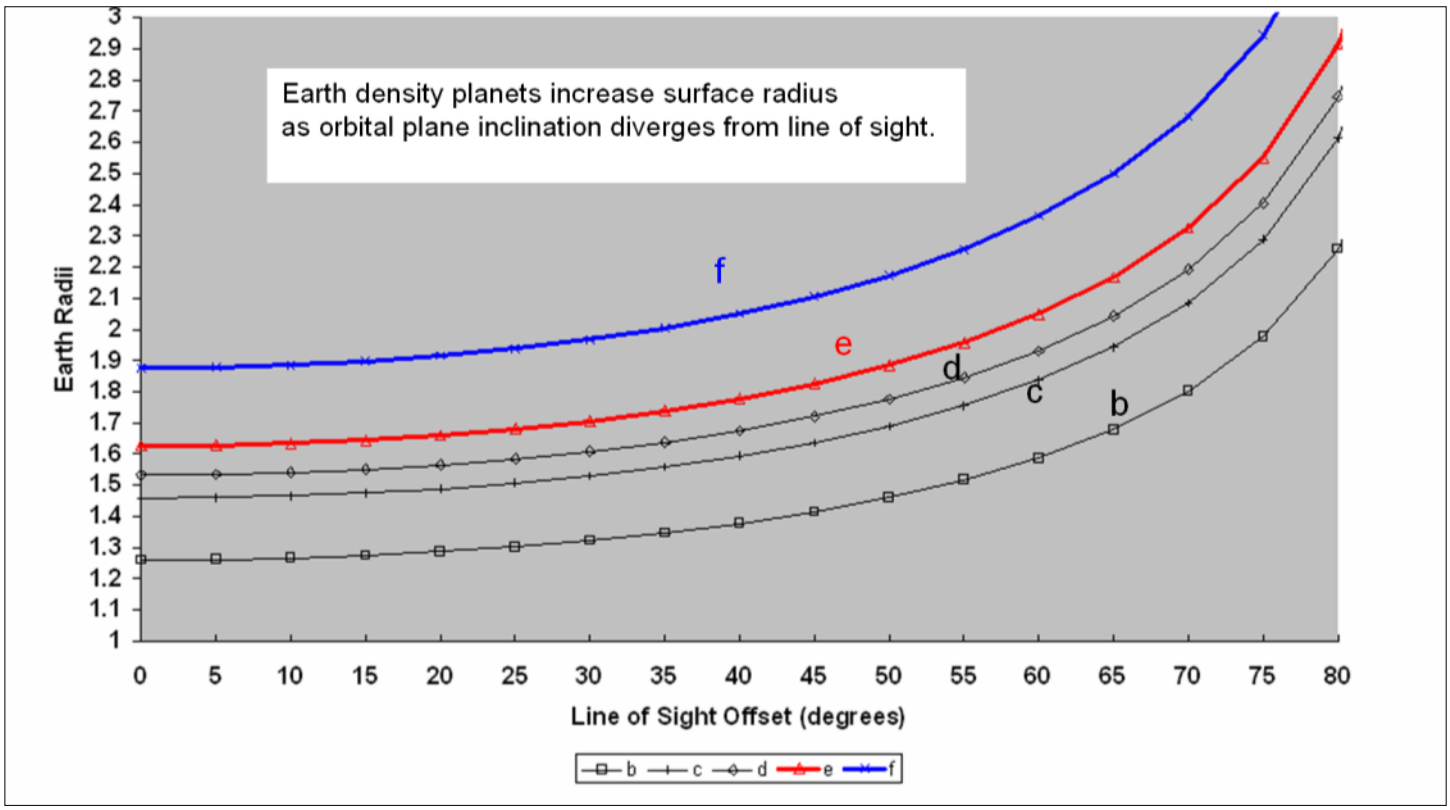


Figure 5. Tau Ceti planets surface radii assuming Earth density & inclination effect.

(Continued from page 24)

References and Links

http://www.centauri-dreams.org/?p=25935#comments

Signals embedded in the radial velocity noise

Periodic variations in the τ Ceti velocities

http://star-www.herts.ac.uk/~hraj/tauceti/paper.pdf

AAS AMERICAN ASTRONOMICAL SOCIETY
ADVOCATES FOR SCIENCE SINCE 1899

http://aas.org
Abstracts for the 221st meeting are no longer available on line, but this sight provides information about coming astronomical conferences and astronomical news.

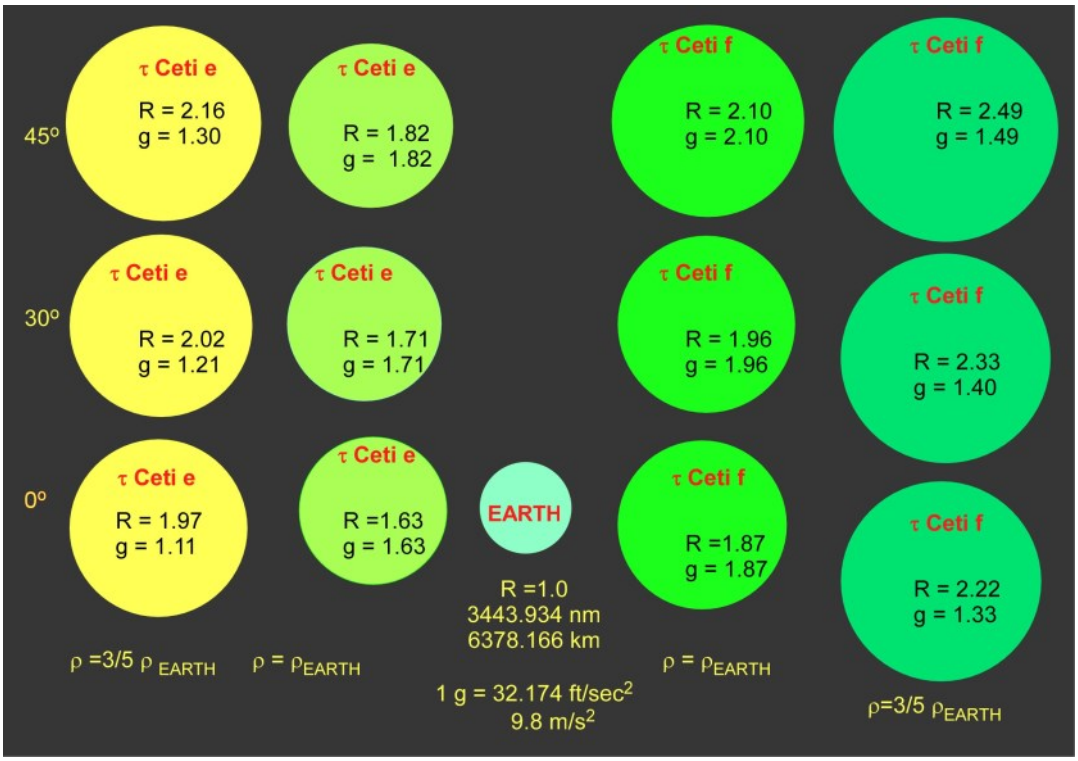


Figure 6. τ Ceti planets "e" and "f": surface radii & gravity for nominal & "3/5" densities mass calculations for 0 °, 30° and 45° inclinations of orbital plane to line of sight.

Museum

1940 Air Terminal Museum at Hobby Airport An AIAA Historic Aerospace Site

DOUGLAS YAZELL, EDITOR

This is a bimonthly column about the 1940 Air Terminal Museum, a 2008 addition to the list of AIAA Historic Aerospace Sites. The museum is restored and operated by the non-profit Houston Aeronautical Heritage Society.

1940 Air Terminal Museum
8325 Travelair Street
Houston, Texas 77061
(713) 454-1940

From the museum news blog entry of January 3, 2013, by Blair (McFarlain): Southwest Airlines has retired the original Shamu airframe, N334SW. This 737-300 was the first airplane painted in the now famous whale scheme. It was done as a cross promotion for Sea World of California and the ship entered service in May of 1988. Over the ensuing years 334 was joined by two additional Shamu painted 737-500s: N507SW and N501SW. They were eventually stripped of their Shamu paint and replaced with two new 737-700s which are still in the fleet and proudly painted as Shamu: N713WN and N715WN. The last revenue flight was on December 9th and the ship is currently in Tucson where it is to be dismantled and scrapped. At this time the airline doesn't know if a third Shamu will join the fleet. But I've got to say that it would be super to see a 737-800 Shamu!

Visit this beautiful and unique museum in person soon! A great opportunity is the monthly Wings & Wheels lunch hour program, 11:00 AM to 3 PM, usually on the third Saturday of the month. Some of the 2013 Wings & Wheels dates penciled in on the web site are March 16, April 20, May 18, June 15, July 20, August 17, September 21, October 19, November 16, and December 21 (HoustonSpotters led by Blair McFarlain are celebrated in December, along with all the museum volunteers!)

Above: Southwest Airlines' Boeing 737 Shamu jets were part of the Sea World California promotion. Image credits: Museum web site (Michael Bludworth).

Above: When teaching people to make balsa wood gliders, we tell them to make them symmetric! Image credits: Museum web site, January 2013.

The Experimental Aircraft Association (EAA) Chapter 12 (Houston)

Mission

The EAA's Chapter 12, located at Ellington Field in Houston, Texas, is an organization that promotes all forms of recreational aviation. The organization includes interest in homebuilt, experimental, antique and classic, warbirds, aerobatic aircraft, ultra lights, helicopters and commercially manufactured aircraft and the associated technologies.

This organization brings people together with an interest in recreational aviation, facilitating social interaction and information sharing between aviation enthusiasts. Many of the services that EAA offers provide valuable support resources for those that wish to develop and improve various skills related to aircraft construction and restoration, piloting, aviation safety and aviation education.

Every individual and organization with an interest in aviation and aviation technology is encouraged to participate. (EAA membership is not required, but encouraged.) Meetings are generally from 6:30 PM to 9:00 PM at Ellington Field in Houston Texas. We welcome everyone. Come as you are and bring a guest; we are an all-aviation friendly organization!

In our May 2011 issue we started our series "EAA/AIAA profiles in general and experimental aviation" with Lance Borden, who is rebuilding his Inland Sport airplane, an aircraft manufactured by his grandfather's 1929 - 1932 company. The second in this series was a profile of Paul F. Dye. The third profile will appear as soon as possible. This series was suggested by Richard Sessions of EAA Chapter 12.

Ideas for a meeting? Contact Richard at rtsessions[at]earthlink.net, Chapter 12 web site: www.eaa12.org. Another email contact: eaachapt12[at]gmail.com. As of April 13, 2012, EAA Chapter 12 is meeting on the first Tuesday of month, based on the calendar on the web site. Experimental Aircraft Association (EAA) web site: www.eaa.org

Scheduled/Preliminary Chapter 12 Event/Meeting Ideas and Recurring Events:

1st Saturday of each month – La Grange TX BBQ Fly-In, Fayette Regional (3T5)
1st Saturdays – Waco/Macgregor TX (KPWG), Far East Side of Field, Chap 59, Pancake Breakfast with all the goodies 8-10 AM, Dale Breedlove, jdbvmt[at]netscape.com
2nd Saturdays – Conroe TX Chapter 302 10 AM Lone Star Builder's Ctr, Lone Star Executive
2nd Saturdays – Lufkin TX Fajita Fly-In (LFK)
2nd Saturdays – New Braunfels TX Pancake Fly-In
3rd Saturdays – Wings & Wheels, 1941 Air Terminal Museum, Hobby Airport, Houston TX
3rd Saturdays – Jasper TX BBQ Lunch Fly-In (JAS)
3rd Saturdays – Tyler TX Breakfast Fly-In, 8-11, Pounds Field (TYR)
4th Saturdays – Denton TX Tex-Mex Fly-In
4th Saturdays – Leesville LA Lunch Fly-In (L39)
4th Saturdays – Shreveport LA Lunch Fly-In (DTN)
Last Saturdays – Denton Fly-In 11AM-2 PM (KDTO)

Below: A Mooney (left) and an RV (right) in August of 2010 at the 1940 Air Terminal Museum at Hobby Airport in Houston, an AIAA Historic Aerospace Site. It was EAA Day for the monthly Wings & Wheels program. Image credits: The 1940 Air Terminal Museum.

Opinion

Climate Change and Local Responses

DOUGLAS YAZELL, EDITOR, STARTING MY CLIMATE CHANGE COLUMN IN THIS ISSUE

My opinions are not necessarily the positions of AIAA or AIAA Houston Section.
editor2012@aiaahouston.org

Additional resources

The Right Climate Stuff (TRCS) team is a Houston Clear Lake area group (mostly from that area) which first met in February of 2012. Most of their membership are veterans of the NASA/JSC community. Their web address is www.therightclimatestuff.com and they recently published preliminary results.

The Climate Abyss is a blog in the Houston Chronicle by Dr. John Nielsen-Gammon.

NASA Global Climate Change
NASA's Eyes on the Earth
My Big Fat Planet
A blog hosted by Dr. Amber Jenkins of NASA/JPL
http://climate.nasa.gov/blog

A 2008 Dr. Kevin Trenberth climate change lecture at UH is reported (pg. 9) in a past issue.

"Expert Credibility in Climate Change, Proceedings of the National Academy of Science (PNAS), April 9, 2010 (sent for review December 22, 2009).

"Here we use an extensive dataset of 1,372 climate researchers and their publication and citation data to show that (i) 97-98% of the climate researchers most actively publishing in the field show support for the tenets of anthropogenic climate change (ACC) outlined by the IPCC, and (ii) the relative climate expertise and scientific prominence of the researchers unconvinced of ACC are substantially below that of the convinced researchers."

Join the Energy Quest. Andrew C. Revkin says that is a better bumper sticker than one saying *Fight the Climate Crisis.* He was writing in a New York Times Dot Earth opinion blog entry of January 29, 2013 (*Other Voices, Can Climate Science Communication Matter?*).

I was between alarmed and skeptical and leaning to being alarmed after attending climate change presentations in September and October of 2011 in the Houston Clear Lake area. The September presenters were skeptical. The October presenters were three university professors, climate science experts in my eyes, and some, if not all three, were alarmed.

An hour of PBS television (Frontline, October 23, 2012, *Climate of Doubt*) put those presentations into perspective. Combining that TV show and its related web page with those 2011 presentations made it easy for me to have confidence in the results presented by the United Nations International Panel on Climate Change (IPCC).

After watching another hour of PBS television on January 4, 2013 (Anthony Leiserowitz of Yale University's Climate Communication project on Moyers & Company, *Ending the Silence on Climate Change*), I started writing this column and suggested adding climate change to our Section's upcoming Annual Technical Symposium of Friday, May 17, 2013, at NASA/JSC Gilruth Center.

Leiserowitz divided his audience into six groups: (1) Alarmed (16% of Americans), (2) Concerned (29%), (3) Cautious (25%), (4) Disengaged (8%), (5) Doubtful (13%) and (6) Dismissive (8%). He encourages public debate, but not climate change debates titled, "Is it Real?"

Full disclosure: after seeing a draft of this article, two NASA/JSC veterans invited me to participate as a member of The Right Climate Stuff (TRCS, described in the sidebar), and I accepted. My proposed climate change columns do not necessarily reflect the views of any group.

Revkin calls attention to the excellent work of Dan Kahan of the Yale University Cultural Cognition Project. *"How much risk do you believe climate change poses to human health, safety or prosperity?"* Science literacy (measured as numeracy, analogous to literacy and as easily measured as literacy) has a weak correlation with where we fall in the range from skeptical to alarmed, but cultural identity has a strong correlation. Science literacy increases polarization on this subject, increasing alarm among the alarmed and increasing skepticism among the skeptical. *Ask not what the new science of science communication can do for you…*

A quick search found three national AIAA public policy information papers. They are not representing the AIAA position: (1) *Essential Capabilities for Operational Climate Change Monitoring* (2010, link not found), (2) *Leveraging Aerospace Capabilities for Climate Monitoring: An AIAA Information Paper* (2010, link not found), and (3) *Advancing and Applying Aerospace Technology to Protect the Global Environment* (2009).

In his 2011 presentation, Dessler summarized results of the IPCC:

- It is virtually certain that the climate is warming, and that it has warmed by about 0.7 degree C over the last 100 years.
- It is very likely that humans are responsible for most of the recent warming.
- If we do nothing to reduce our emissions of greenhouse gases, future warming will likely be at least 2 degrees C over the next century.
- Such a climate change brings with it a risk of serious adverse impacts on our environment and society.

A friend sent me a link to *How to Talk to a Climate Skeptic*, by Coby Beck at a web site called Grist, an environmental news and commentary web site. The same friend sent me a link to *How we Know Global Warming is Real and Human Caused* (February 8, 2012), by Donald R. Prothero, writing on a web site called Skeptic.

In his 2010 book *Storms of My Grandchildren*, James Hansen writes about data, just before his Figure 2: "...they take a scientific approach; they give primacy to real data. Theories and models of the future can help organize one's thoughts, but they are only useful if they explain the real world. A convincing analysis must start with and place most weight on data and real-world observations."

Dessler's charts include a letter to a Senator on this subject. Other local responses: talking to friends and questions such as, *"If sea level rise combines with a hurricane to damage our roads, should we create new standards before rebuilding?"*

Science Fiction by Scientists

Book Review

PRESS RELEASE

AIAA Houston Section member Dr. Larry Friesen has recently had a book published. It is a work of science fiction: three novellas published as a collection. The publisher is Firefall, whose web site is www.firefallmedia.com.

No two of the stories are connected. In fact, they don't even inhabit the same "future history." The overall title of the book is Betrayal/Battle/Storm.

The first story is "Buddy System." A geologist/planetary scientist stationed at a lunar settlement wakes up in a pressurized lunar rover, while on an exploratory probe well away from the base. He realizes (a) he has been unconscious, and (b) his partner on this expedition is nowhere to be seen. Both men seek the affection of the same woman, and jealousy has reared its ugly head. His partner has sabotaged the rover, but has made it look like an accident due to poor maintenance. It's basically a survival story: The geologist knows of a supply cache he just might be able to walk to. Question: can he make it before his one remaining air tank is exhausted? That's the "Betrayal" part of the title.

The second story is "Sail a Dusty Sky." It's a combination of a love story and a survival story of a different sort. It's the first human expedition to Mars. Two ships (with two landers), a dozen crew members, six in each ship. Two members of the expedition are on a long-range cruise in a giant blimp that's just able to carry the two of them and a modest payload. The two are the pilot, a man, and the woman he is in love with, a scientist. He tries to win her affection and commitment. She sends back mixed signals; part of the time she responds to his attempts, part of the time she rebuffs him. When the blimp is more than a third the way around Mars from the landing site, they get caught in a dust storm that sends them crashing to the ground, breaking open a couple of the blimp's gas cells in the process. Can they repair the tears in the cells? Do they have enough lifting gas (hydrogen) left to re-inflate the blimp? And can they do everything to get the blimp back to the landing site in time to make the launch window for the return trip to Earth? (The planets wait for no man.) That's the "Storm" part.

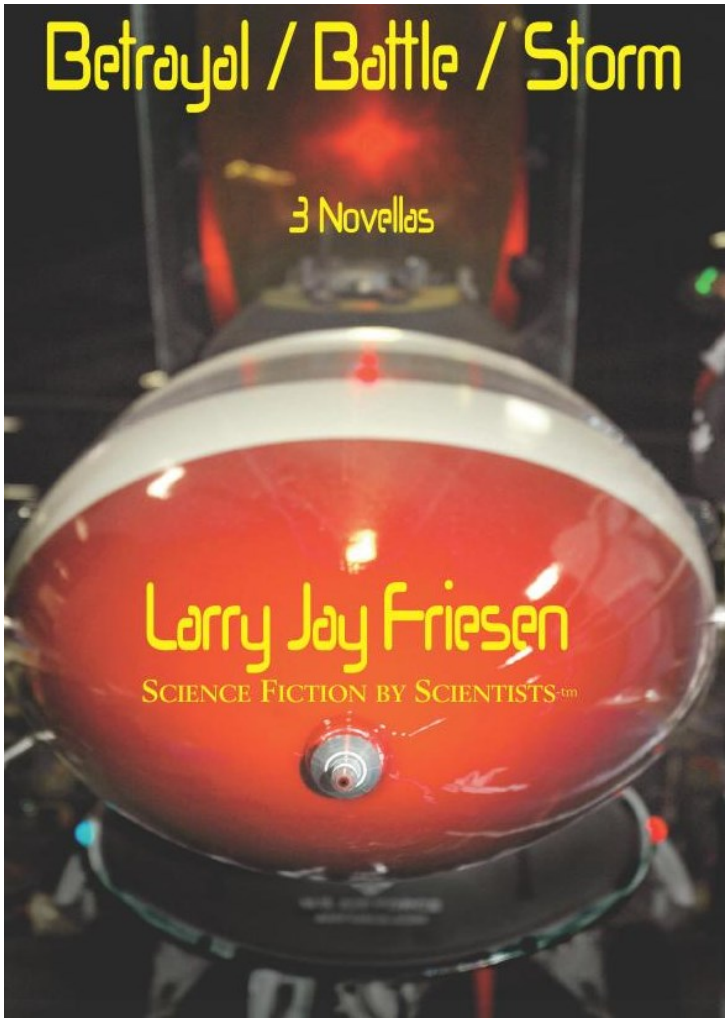
The "Battle" part is the third story, "Armor in Aristoteles." It is a conflict story: a tank battle on the Moon. A hypothetical future mid-East nation is trying to develop nuclear weapons in secret. By this fictional future date, there are multiple bases and even communities on the Moon, sponsored by various nations. The US has one (with contingents from various countries, but the US is the major sponsoring power); the mid-East nation has another. Espionage work finds that in order to hide its work from inspectors, the mid-East nation is moving the nuclear project to the Moon. Each side starts a clandestine buildup of military personnel and weapons at or near its own base. A triggering event sets the forces in motion against each other.

With a PhD from Rice University in Space Physics & Astronomy, Larry Jay Friesen worked at Johnson Space Center from 1976 through 1998, mostly for McDonnell-Douglas and Lockheed-Martin. He currently teaches Astronomy and Physics at the University of Houston - Clear Lake. He was elected as an Associate Fellow of the American Institute of Aeronautics and Astronautics (AIAA). He brings a wealth of accurate detail to the highly probable reality of his stories.

photo: Martha Friesen

firefall™

Above: Larry Jay Friesen, author of the new book Betrayal / Battle / Storm, published by Firefall. Image credit: Martha Friesen.



Crowdfunding

Kickstarter for Space Projects

SHEN GE, CONTRIBUTOR

Above: Covers of the recent issues of Horizons. Each cover image is linked to a PDF file for the corresponding issue. Image credits: Horizons.

Thousands of individuals contribute information to Wikipedia, an example of crowdsourcing. Take this one step further and have individuals contribute money instead. This is crowdfunding. This method of funding circumvents traditional sources and gatekeepers, allowing a grassroots method of wealth distribution to interesting projects. The largest crowdfunding site is Kickstarter. As of March 2012, web users had pledged more than $165 million to millions of projects.

Kickstarter is simple. As a project starter, you set a target date (two months or less) to fund a goal, a target monetary amount. You then set various donor rewards depending on the level of donation which can range from $1 to any amount. If by the target date, the goal has been reached, you take about 90% of the donations, while 5% goes to Kickstarter and 3 to 5% goes to Amazon Payments for processing donations. If the goal is not reached by that date, you get nothing. Typically, a project either makes the goal or finds little support. A good idea, demonstrated credentials and a good pitch are essential for generating enough support.

Though the initial set of projects which used Kickstarter were mostly in the arts, other fields successively followed suit. Over the last year, there has been an upsurge in popularity in using Kickstarter to successfully fund space projects. Let's go over a few projects that have been successfully funded and then bring up the use of Kickstarter for funding a print version of Horizons, the newsletter of AIAA Houston Section.

1. LiftPort

http://www.kickstarter.com/projects/michaellaine/space-elevator-science-climb-to-the-sky-a-tethered

http://www.liftport.com/

Goal: $8,000
Funded: $110,353
LiftPort, an idea started by engineer Michael Laine of Seattle, is a company started in 2003 to investigate building a space elevator on Earth. They researched carbon nanotubes but concluded they would not help. However, LiftPort worked on building robots that can climb a tether. At one point, they had 60 university research partners and between 800 and 1,000 volunteers working on the project. But the economy crashed in 2007 and LiftPort went downhill.

Their revolutionary idea is to build a space elevator on the Moon. With current technology, it is feasible to build it in eight years. LiftPort will build a tethered tower as a precursor to the lunar elevator. A robot will climb 2 kilometers to the platform of high-altitude balloons tethered to the ground. This will build upon the climbing robot experience acquired by LiftPort in the past.

2. ArduSat

http://www.kickstarter.com/projects/575960623/ardusat-your-arduino-experiment-in-space

http://www.nanosatisfi.com/?page_id=16

Goal: $35,000
Funded: $106,330
ArduSat's mission is to provide affordable space exploration for everyone by building an inexpensive satellite, Arduino. This miniature cube satellite, measuring 10 cm along each edge and weighing 1 kg, will have more than 25 sensors including three cameras, a Geiger counter, a spectrometer and magnetometer. These sensors are connected to a bank of programmable Arduino processors which can run the pledgers' applications or experiments. The pledger will be the user.

Through a web interface, the user can upload code to an exact replica of the satellite on the ground to ensure that it works. After some tests and any needed modifications, the code will be uploaded into ArduSat where the application can run and gather data. Once the time the user has booked with ArduSat expires, the data will be sent to the user via the Internet.

3. KickSat

http://www.kickstarter.com/projects/zacinaction/kicksat-your-personal-spacecraft-in-space

http://www.spacecraftresearch.com/MII/MII_overview.html
https://github.com/zacinaction/kicksat
http://www.kickstarter.com/projects/251588730/kicksat-your-personal-spacecraft-in-space/posts

Goal: $30,000
Funded: $74,586
Zac Manchester, an aerospace engineering student from Cor-

(Continued on page 31)

(Continued from page 30)

nell University, designed, built and tested a very tiny and inexpensive spacecraft called Sprite. It is about the size of a few postage stamps but contains solar cells, a radio transceiver, and a microcontroller with memory and sensors. Each Sprite will cost $300 to launch.

KickSat will be a CubeSat that will be designed to carry hundreds or thousands of Sprites into low earth orbit. Initially housed in spring-loaded stacks and held in place by a lid, a transmitted radio signal will open the lid, releasing the Sprites as free-flying spacecraft. These Sprites will then be tracked and recorded by an international network of amateur ground stations. The Sprites will last a few days or weeks before entering the Earth's atmosphere leaving no traces of space debris.

4. Final Frontier Design's 3G Space Suit

http://www.kickstarter.com/projects/872281861/final-frontier-designs-3g-space-suit

http://finalfrontierdesign.com/

Goal: $20,000
Funded: $27,632
Final Frontier Design (FFD) is a company designing and building a lightweight, inexpensive, and highly functional space suit for the new space industry. The FFD Third Generation (3G) Suit will follow NASA flight certification standards and will be an upgrade over the 2G Suit, including such features as a higher operating pressure, a carbon fiber waist ring, a retractable helmet and improved gloves and glove disconnects. The 3G Suit is intended for Intra Vehicular Activity (IVA) which will be used in case of an emergency loss of cabin pressure. The up and coming space industry including SpaceX, Boeing, Sierra Nevada, Virgin Galactic, Armadillo, Blue Origin, STAR Systems, XCOR and any other suborbital or orbital spacecraft company will need these suits for the basic safety of crewed flights and they will need a cheaper alternative than current NASA suits which cost well into the millions of dollars.

5. Hermes Spacecraft

http://www.kickstarter.com/projects/hermesspace/hermes-spacecraft

http://www.hermesspace.com/

Goal: $20,000
Funded: $20,843
Space Transport and Recovery Systems, LLC (STAR Systems) is a startup aerospace company working on the Hermes spacecraft, a reusable suborbital spacecraft. Hermes is a vertical takeoff, horizontal landing vehicle that can carry four passengers to an altitude of 62 mi (100 km) with a maximum velocity of 2,300 miles per hour (3,700 kilometers per hour). An encrypted remote cockpit system will allow the spacecraft to be controlled remotely for low altitude test landings.

STAR Systems already has a full scale prototype of the Hermes structure. They only need help to create a full size prototype of the rocket motors. For propulsion, Hermes will use a hybrid rocket motor 10 inches in diameter capable of 5000 pounds of thrust. The donated funds will be used for buying sensors, data acquisition hardware, materials, tier awards and fees for both Kickstarter and Amazon.

AIAA Houston Section's Horizons newsletter will use Kickstarter as a means of generating at least $2000 for 200 printed copies of one issue (a special version reduced to 36 pages in length) for marketing and publicity. These magazines will be offered at events and online for tax-free donations of $7. Once we sell all 200 copies, we can print 200 copies of the next issue, so the continuing operation pays for itself after a successful crowdfunding. We prepared the video (already on YouTube), arranged for pledger gifts (NASA medallions and more), and now we are ready to put it all on our own Kickstarter web page and start our crowdfunding. Please look for us on Kickstarter and pledge your support.

Crowdfunding

Above and below: Covers of the two most recent issues of Horizons. Each cover image is linked to a PDF file for the corresponding issue. Image credits: Horizons.

SPACE, the Academy

The First SPACE Retreat

SHEN GE, CONTRIBUTOR

An earlier SPACE event took place on the Isle of Man. Horizons reported on that starting on page 20 in the January / February 2012 issue.

Above: A chart about university plans for SPACE.

On January 8, 2013, a group of space professionals and enthusiasts gathered at a vacation apartment called Tropical Park in a little town called Callao Salvaje on the tropical isle of Tenerife, one of the Canary Islands. There, under the sunshine of an eternal summer between episodes of going to the beach and eating plenty of Canarian chicken and other local culinary delights, these dozen or so folks gathered together for serious presentations and discussions on the various aspects of space and space habitation. All presentations started at ten o'clock in the morning to accommodate for people's potential late nights. This "unconference" organized by the Scientific Preparatory Academy for Cosmic Explorers (SPACE) hoped to gather together people from diverse backgrounds with the common goal of sharing knowledge and building together a roadmap for space habitation.

Above: The Observatorio del Teide (Teide Observatory) is an astronomical observatory on Tenerife operated by the Instituto de Astrofisica de Canarias. Opened in 1964, it became one of the first major international observatories, attracting telescopes from different countries around the world because of the good astronomical seeing conditions. Later the emphasis for optical telescopes shifted more towards Roque de los Muchachos Observatory on La Palma. It is considered one of the world's major observatories. Caption: Wikipedia. Image credit: SPACE.

On the first day of presentations, Shen Ge talked about the purpose of Scientific Preparatory Academy for Cosmic Explorers (SPACE) and the plans for making SPACE the organization to create the human talent for a spacefaring civilization. Shen discussed the ways that SPACE is acquiring attention and money, including planning events such as this SPACE Retreat. Another example is an educational module to be ready later this year or early next year. It will consist of spacecraft and space mission design taught at foreign universities that do not have such a program. The foreign university will pay SPACE instructors to teach such courses at the respective university. Within the next five years to a decade, SPACE will garner enough donations and sponsorships to build its own campus.

Ryan Haughey, a student under Dr. David Hyland, an aerospace engineering professor at Texas A&M University, made the next presentation. He spoke about the spacecraft which he and 33 other students designed as part of a spacecraft design course. The design is for an interplanetary spacecraft that can fly 2-3 years with a crew of 12. This project is very ambitious and will cost far more than the F-35 Joint Strike Fighter, an aircraft which required about $1 trillion to develop. Nonetheless, its consequences for humanity will be far greater.

Later that night, Dr. Hyland talked about the overall plan for the human habitation of the solar system. Since he couldn't make it in person due to family obligations, the presentation took place using Skype. Despite connection issues, the attendees were able to acquire an understanding of the roadmap for space habitation as envisioned by Dr. David Hyland. After this presentation, the attendees were treated to an appetizing dinner party with plenty of sangria and wine.

On the second day, Virgiliu Pop, a space lawyer currently working for the Romanian Space Agency (ROSA), talked about the legal considerations of asteroid exploitation and deflection. He pointed out that asteroids aren't considered things that can be owned. However, claiming ownership is an issue since some people might do it, and just stating that you own an asteroid does not imply real ownership. Robots may make the case for ownership. A recent shipwreck was recovered by robots. Virgiliu's second topic was the legal or moral obligation of people to deflect an Earth-impacting asteroid. Apparently, there are no legal obligations but there are definitely moral ones. Finally, Vrigiliu described the Sagan dilemma, "The same technology used to deflect an asteroid can be used as a weapon to harm Earth." This issue might prevent testing of asteroid deflection techniques.

Roy Tucker, famed asteroid discover (Wikipedia, extracted February 7, 2013: "He is a prolific discoverer of asteroids, identifying at least 404 and co-discovering one between 1996 and 2009."), next gathered

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everyone around for a roundtable discussion (using a rectangular table) about achieving space habitation. Three topics were addressed: financing, technology, and the will. For financing, the several topics addressed included resources (asteroid mining), energy (asteroid mining), people (tourism), and intellectual ideas (science, entertainment). For technology, Roy directed the conversation to rotovators, telepresence, and digital immortality. For the will, Roy suggested the Pilgrim analogy where people initially venture forth to escape confinement on Earth and seek freedom of expression.

Caption: Rotovator concept image from Wikipedia. Douglas will crop the bottom of that image and add the caption and image credit from Wikipedia.

On the third day, there was a break from presentations. We piled into a bus for a memorable trip to the World Heritage site called El Teide, an active volcano in the middle of the island. The landscapes there were truly extraordinary, often seeming to be from another planet or the Moon. On top of the volcano was the Teide Observatory. The attendees were taken on a tour of several telescopes including the oldest telescope called the Carlos Sanchez Telescope.

On the fourth day, futurist Philippe van Nedervelde, a technology nomad and entrepreneur, gave a talk on avatars and digital immortality as predicted by the 2045 Initiative. The 2045 Initiative is a projection of what the world will be like in 2045. Philippe is a transhumanist who aspires to achieve immortality in his lifetime. He fully supports the 2045 Initiative which was started by a Russian millionaire named Dmitry Itskov, a man who also has aspirations for immortality. The phases leading to immortality by 2045 will take place every ten years or so starting from now. Phase 1 is training for a non-biological body as depicted by the movie Surrogates. Phase 2 is brain sustainability where the brain can survive despite bodily destruction. Phase 3 is where the mind is substrate independent, no longer tied to the organic grey matter in our noggins. Phase 4 is where substance-independent minds will receive bodies with capacity far exceeding that of ordinary humans.

Megan Heard next presented on the life support system for the interplanetary spacecraft which Ryan Haughey presented to us on the first day. Diet will be similar that of the Ikarians, a Greek island people renowned for their longevity. Aeroponics will be used to grow many of the plants which can reduce water usage by 98% and reduce fertilizer usage by 60%. Plants will be grown in microgravity since reduced gravity encourages faster plant growth. One thing to be stressed in terms of microgravity is that despite over five decades of crewed spaceflight, there still has been no test on what level of gravity

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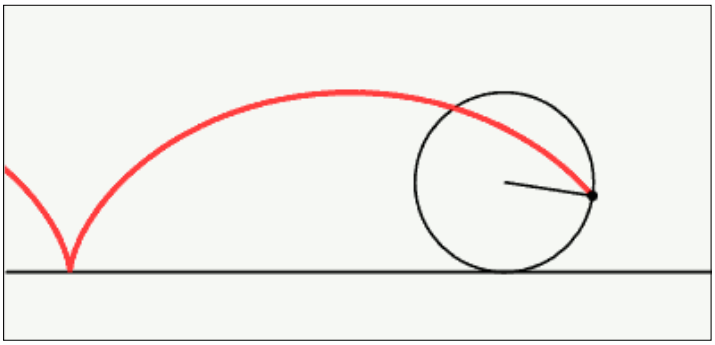
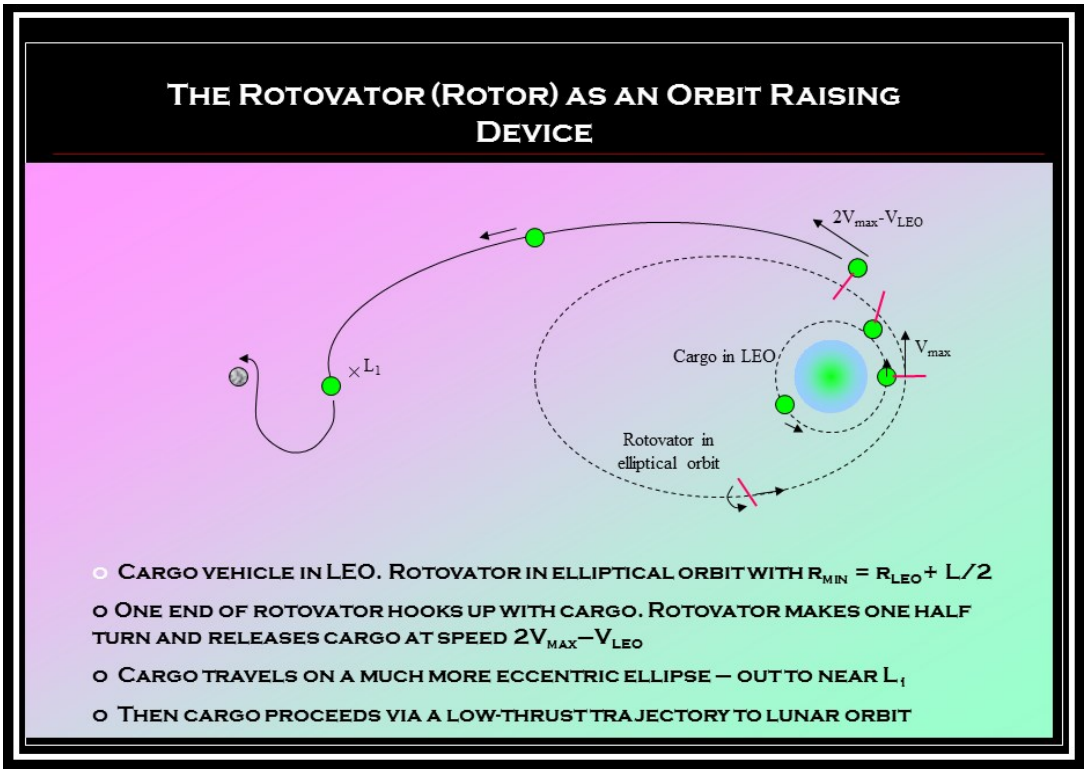


Above: [Horizons Editor] Regarding rotovators, this image and the following caption from Wikipedia. If the orbital velocity and the tether rotation rate are synchronized, in the rotovator concept the tether tip moves in a cycloid, and at the lowest point is momentarily stationary with respect to the ground. (Image from the cycloid article.) Image credit: Wikipedia.



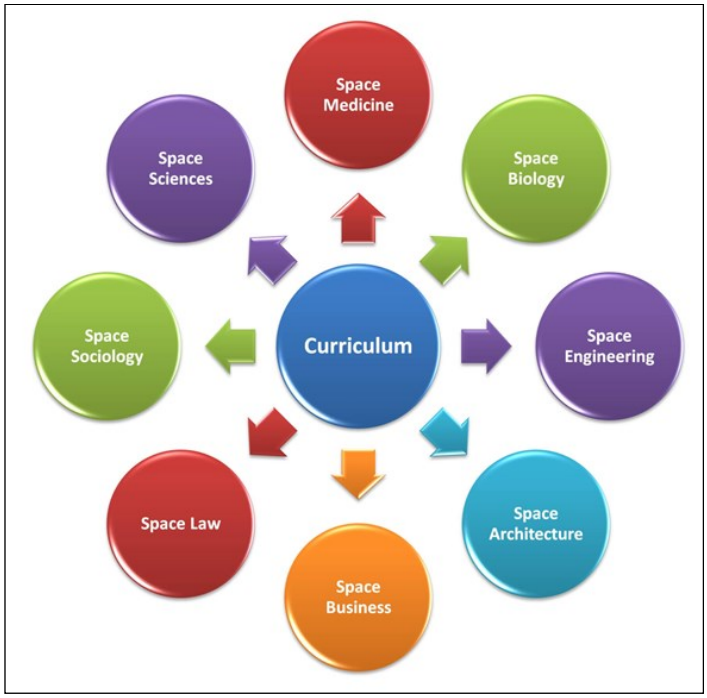
Above: An example of space applications for rotovators. Image credit: Dr. David Hyland.

SPACE, the Academy

(Continued from page 33)

humans can actually sustain. Scientists know that 0-G is bad and 1-G is good. Between those values, little is known. The space habitat can also serve as a test of human conditions in varying gravity.

Hyerim Kim next presented on the interplanetary superhighway which uses weak stability boundaries to create low-thrust trajectories. The homoclinic chain system of orbits just inside or outside another orbit system and the heteroclinic chain system of orbits around Lagrange points L1 and L2 are orbits of invariant manifolds which can be used for traveling around the inner solar system on the way to asteroids. Heteroclinic orbits are orbits in space which join two equilibrium points, whereas homoclinic orbits are a subset of heteroclinic orbits that have the same starting and ending equilibrium point.



Above: Examples of subjects in the curriculum of the Space Preparatory Academy for Cosmic Explorers (SPACE). Image credit: SPACE.

On the fifth day, Roy Tucker presented on how he hunts for asteroids. He went over the history and then the modern method which he uses called scan-mode imaging. Roy ended his talk by showing the software Pinpoint which he uses to find asteroids. Though the program can automatically detect asteroids, the naked eye is still superior in detecting minute differences.

Amanda Shayle, an acupuncturist, next presented on how acupuncture can be used to affect the largest organ in the body, the skin, and how such techniques can be useful in a space environment. She then gathered up her needles and demonstrated on Iulia and Megan.

On the sixth day, Iulia Jivanescu, an aerospace engineer working for the Romanian Space Agency (ROSA), talked about space systems as critical infrastructures and system engineering elements used to categorize and give importance to different parts. Ina Mertens, the Eastern European space art historian, went over the history of space art and presented a number of interesting images from the early days of the 20th century to the present.

On the seventh day, Alan Pritchard, a systems engineer, presented on the holistic approach he and his company Zen Systems developed towards space. A key point is that space should not be considered separate from Earth. It is a part of Earth and can be realistically reached. Parts of Earth are harder to reach than space but are not treated with such awe.

Erik Unger, a software engineer and entrepreneur, next presented a number of stunning videos of games that he has worked on and his own projects of the moment which include web software for ground tracking, videos for the space elevator startup Liftport Group and Unmanned Aerial Vehicles (UAVs).

On the eighth day, Shen Ge, aerospace engineer, presented an overview of asteroid mining concepts which included composition, mining, astrodynamics, economics and law. Antoine van de Ven, a physicist and cognitive scientist, presented his revolutionary physics theory where antimatter

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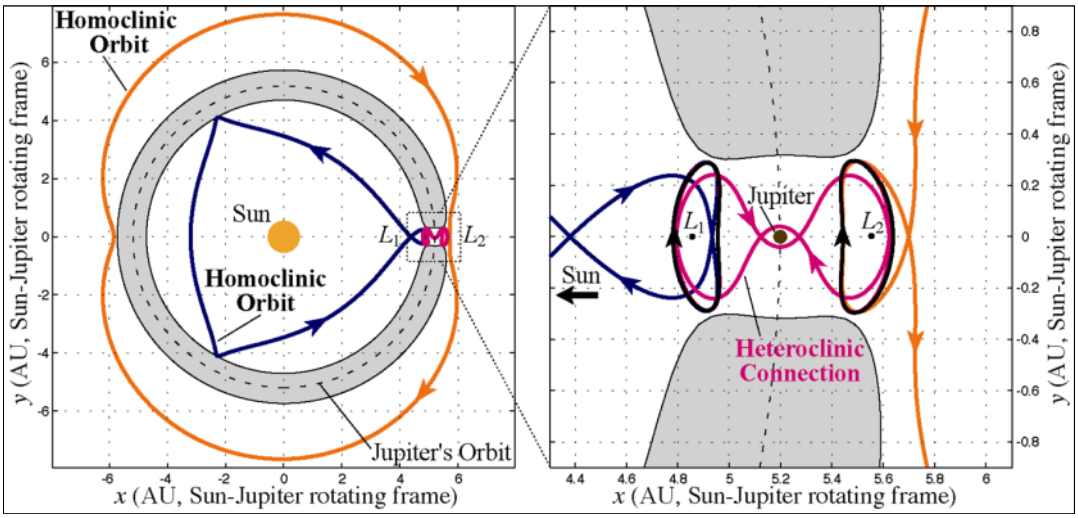


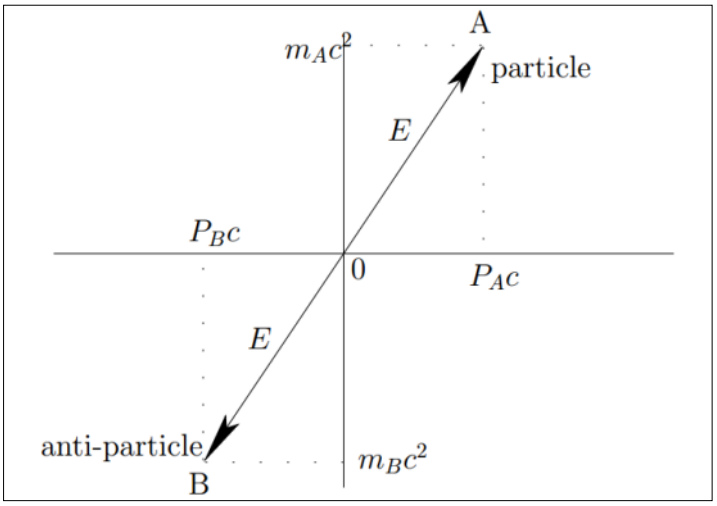
Above: An example of homoclinic orbit change and heteroclinic orbit chains for navigating to Jupiter. Image credit: SPACE.

repels instead of attracts. Using such negative-mass antimatter, a future spaceship can be propelled through space by creating interaction of antimatter with normal matter. Antoine admitted that he will not receive a Nobel Prize unless this is tested experimentally, and tests will require precise measurements between two antineutrons at a facility such as CERN. Antineutrons are antiparticles of neutrons that are just as electrically neutral as neutrons, making the effect of gravity, or anti-gravity as Antoine predicts, much more noticeable and hence potentially detectable.

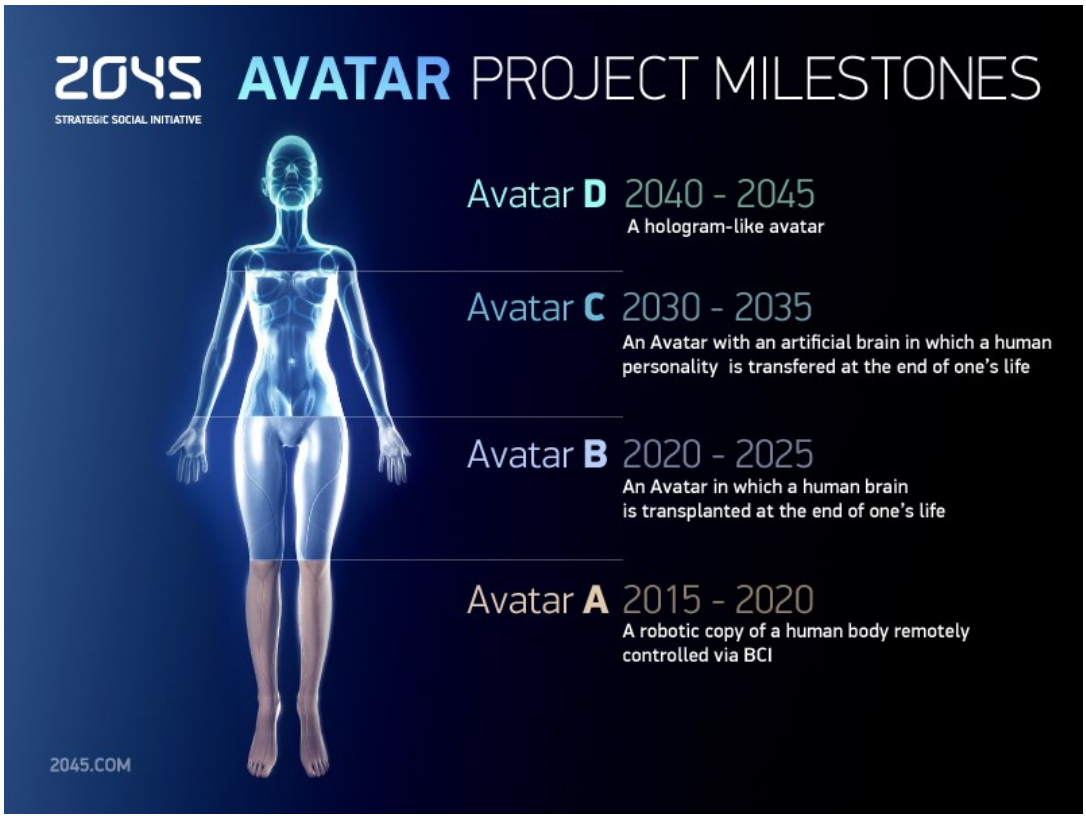
On the ninth day, Dragos Bratasanu, researcher at the Romanian Space Agency (ROSA), presented the human elements of space projects and team work. The social context behind the engineering failures such as the Challenger disaster and the Hubble telescope optics misalignment is often invisible, unacknowledged, and immeasurable. Dragos presented on the four types of team builders as outlined by Carl Jung's theory. Erik Unger decided to give another look at this theory by presenting a personality chart with Asian elements called Roger Hamilton's wealth dynamics. Prasanna Deshapriya, a Sri Lankan student of astrophysics and an astronomer, presented on space tourism. He discussed what's happening today and what the future will hold.

Though the SPACE Retreat formally ended on January 22, 2013, its 14th day, there was a final lunch with futurist Philippe van Nedervelde on the 11th day. Though the discussion was supposed to be on the preservation of humanity, since Philippe also wears the hat of spokesperson for the Lifeboat Foundation, it was hijacked by talks on panoptical systems, nearly undetectable and inexpensive optical sensor systems that will eliminate privacy as we know it. This smart dust can be anywhere and view anything anyone does. Since governments are already working on such a system, Philippe suggested that the only way to ensure personal freedom is to democratize it and allow private citizens as well as companies to spy on people. As far as lifeboats go, aside from space habitats and extraterrestrial settlements, Philippe suggested that humanity can use underground bunkers such as those built in Switzerland during World War II.

The two remaining days were full days of relaxation where the remaining attendees discussed what was learned and formulated plans in drawing out the space habitation roadmap in the upcoming weeks. The first SPACE Retreat was a success. It will be an annual event, and the second SPACE Retreat will take place in Florida or Puerto Rico early in January of 2014.



Above: Two energy-momentum four-vectors can be visualized in this diagram where the length of the vector, the energy, remains the same for both whereas the mass is negative for antimatter. Energy as stated by Antoine is equivalent to the positive square root of the sum of the squares of the two quantities, (1) mass times the speed of light squared, and (2) momentum times the speed of light. Image credit: Antoine van de Ven.

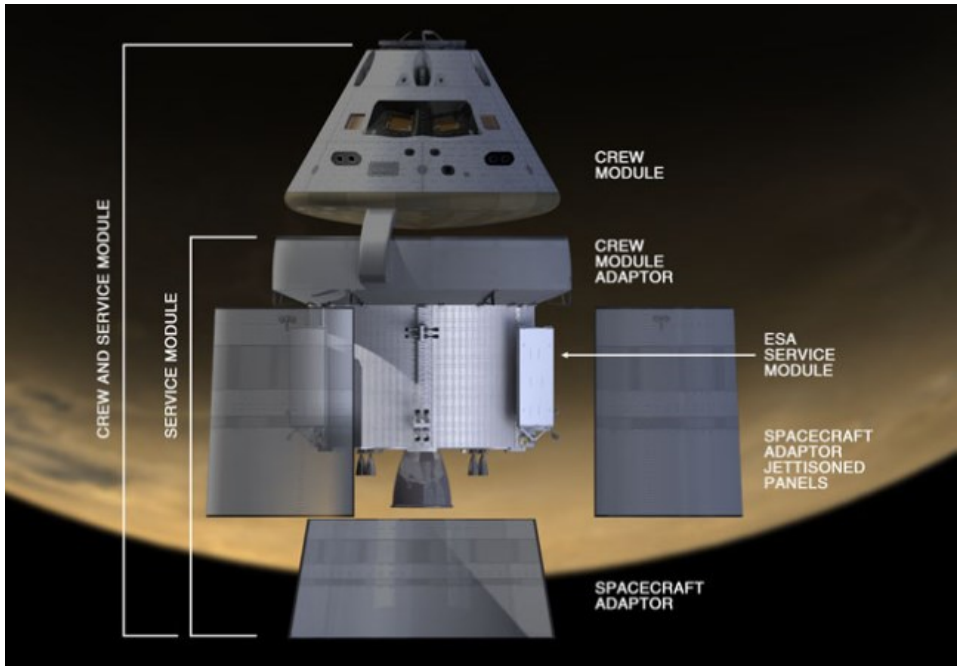


Above: Project milestones for the 2045 Initiative. Image credit: Philippe van Nedervelde.

Staying Informed

A question from the NASA/JSC press conference of January 16, 2013. (Image credit: NASA.) See our article later in this issue.

NASA Signs Agreement for European-Provided Orion Service Module



From Gina Sunseri of ABC News. "This questions is for Bill Gerstenmaier and for Mark Geyer: How tough is it to design a system like this when you don't know exactly where you are going? You know you can go to the [International] Space Station but you don't know if you are going to the Moon or Mars or an asteroid. Mark, when I interviewed you last year the plan was an asteroid. Well, how do you design a vehicle when you don't really know where it's going to go?"

Bill: "We have the basic requirements understood. We know what change in velocity or how much propellant this vehicle needs to carry. We know what its basic structural load capability is. We know how long the life support systems need to be there. We know how many crew we're going to carry. We know all of those parameters. You don't design a car to just go to the grocery store. You design a car that can go to the grocery store, go to the shopping mall, maybe drive across the country and do other things. It's the same kind of thing here. As engineers we take those basic requirements to do these multiple destinations, these multiple locations, and we're building a system that will allow us to go explore those. We no longer want to build a system that is optimized for one particular destination. We want a system that can actually push human presence out into the solar system and allow us to go to all of these different destinations. We broke it down into the requirements that allow us to capture all of these destinations, scarred some interfaces to grow a little bit in the area. The teams are very comfortable with what we laid out in front of them. They understand the requirements they need to build to."

Mark: "Bill said it great. This vehicle has lot of capability to do a lot of different missions. When you talk about volume and delta V and ability to carry crew it's really got a lot of flexibility. Do we participate in those architecture studies that happen at headquarters when they talk about new missions to make sure that we understand what, if any, updates we would need to make? [Yes.] Even at this point, with all of those different discussions, our plans with EM-1 and EM-2 have not changed because this is a very capable vehicle."

From http://collectSPACE.com:

February 20, 2013: Friendship 7 "found" in Texas: For at least the past four decades, a full-size model of a Mercury spacecraft has sat at the corner of Red Bluff Road and St. Augustine Avenue in Pasadena, Texas, located about 20 minutes from the Johnson Space Center. Sometime in the past few years, the capsule was repaired, restored and repainted, in the process gaining the logo of Friendship 7, John Glenn's capsule that he flew into orbit 51 years ago. *Image credit: collectSPACE.*

[Editor: I saw this from a distance recently as I drove by. I was tempted to return to report on this for Horizons and for my own curiosity. collectSPACE did a great job of reporting on this, but we all probably want to know even more about this mockup.]

Science Fiction Author Boris Strugatskij

WES KELLY, TRITON SYSTEMS, LLC

In the Russian Community bi-weekly newspaper *Nash Texas*, Russian for *Our Texas,* serving much of the state, an article appeared noting the passing of a significant Russian cultural figure, one of the many icons of a generation or two, but also, significantly, an icon of those who have participated in international space flight. What follows is a fairly literal translation of the text, interspersing some of the accolades (italics) from prominent Russians that had originally appeared at the end of the article.

The Death of
Boris Strugatskij
Reported 29 November 2012

On 19 November in the Almazov Hospital in St. Petersburg expired Boris Strugatskij, a legend of Soviet and Russian science fiction ("fantastika"). He was 79 years old. Together from their very first appearance the Brothers Strugatskij, a writing duet, more than many others influenced the generation of the 1960s to 80s.

Yurij Arabov, screenwriter says, *"It is simply not adequate to say that two classical (artists) have left us. The Strugatskijs in my opinion were the best subjectivists of our 20th century literature, if, under a subject, it's necessary to understand not only the content of events, but also the intent of what is said. Their subjects are absolutely brilliant. For example, 'Monday Begins on Saturday' in 1964. We grew up with that literature. Boris is gone. But beside everything else previous, this social activist performed the duty of our intelligentsia: to act in behalf of the fallen. Here, that is all I can say about this."* [Arabov was screen writer for the 1988 film adaptation of the Strugatskij story, "Day of Eclipse" (Den' Zatmeniya) – more about this below].

Boris Strugatskij was born April 15, 1933 in Leningrad. The future writer's father worked in the Russian State museum. His mother was an instructor teaching Russian literature in school where Boris himself studied. The war years separated the family. During the Great Patriotic War the Strugatskij family found itself in besieged Leningrad. Because Boris was ill in January 1942, Arkadij and Nathan Zalmanovich Strugatskij were sent to the evacuation point by themselves. Only in 1943 did the older brother Arkadij succeed in bringing his mother and brother Boris to the village of Tashel in the Orenburg Region (then the Chkalov Region [so named, presumably for the pioneer Soviet aviator]). They returned to Leningrad in 1945. In 1950 Boris finished school with a silver medal and planned to enter into the physics department of Leningrad State University. However, for a number of reasons he was not accepted. He then offered documents to the mathematical and mechanical physics department where he completed studies in 1955, under the specialty of "stellar astronomer."

"Boris Strugatskij remained the last of the cohort of the best Soviet artists, writers, cinematographers, in the ranks with [Andrej] Tarkovskij and [singer, actor, composer] Vladimir Vysotskij. He was a living messenger from that time, one of not so many who in the 1990s did not change himself but remained an establishment figure," the publicist Dmitrij Bykov [a frequent contributor to the long-lived national weekly magazine Ogonyok] wrote in eulogy for the writer. "He was absolutely, an undiluted genius. And who is there to compare him with today? I do not know of anyone. His death is a catastrophe of the scale of [folk singer and song writer] Okudzhava's passing. With his departure, all has become still darker and more airless," Bykov said.

Bykov distinctly remembers the time when he was first acquainted with the creativity of the Strugatskij brothers. "It was a collection of1962 science fiction stories and [I was] in Russia [and] it was 1975. I was sick and 8 years old when I read 'Attempt at Flight' [or 'Escape Attempt']. It was the first time in my life that I read text that I could not physically pull myself away from. And all night I read, until I had it all. For me every new [piece of] writing from the Stugatskis was such a discovery. From the first page, I fell prisoner to that text."

The first collaborative production of the Brothers Strugatskij saw light in 1958 – in the magazine *Technology for Young People (Tekhnika Molodezhi*) in which was published the story *From Without*, writing of the comings to Earth of visitors from space. In 1960 there came out another novella. And then a year later the Strugatskijs released their first book, *The Land of Purple Clouds*.

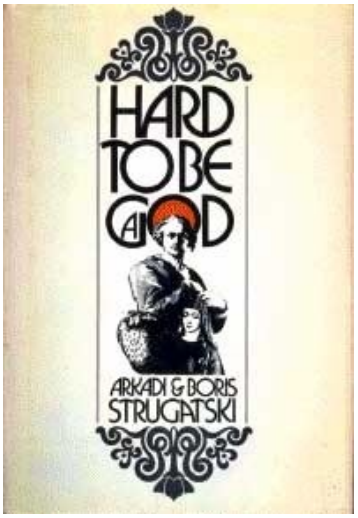
(Continued on page 38)

Above: A file photo of the late Boris Strugatskij from the internet or the Our Texas web site, also found at Examiner.com.

НАШ ТЕХАС
Our Texas

Above: The biweekly newspaper Nash Texas (Russian for Our Texas), the primary source for this article, translated by Wes Kelly, Triton Systems LLC.

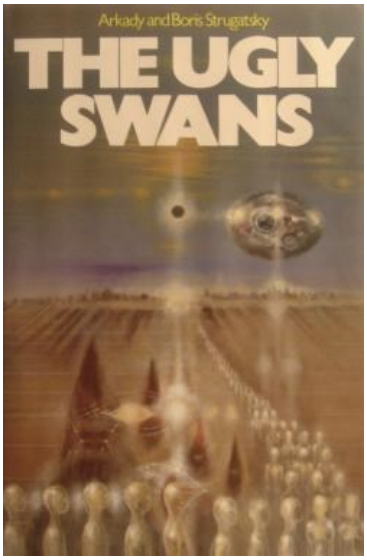
Newspaper web site:
www.ourtx.com

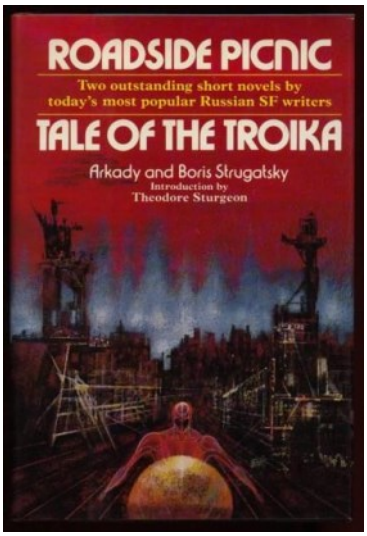


Above: Book cover image from Wikipedia citing fair use. The image is linked to the related Wikipedia web page.

Current Events

Above: A file photo of the late Arcadij (left) Boris Strugatskij from the internet, also found at TV Tropes.





Above: Book cover images from Wikipedia citing fair use. Each image is linked to the related Wikipedia web page.

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Within less than 10 years they created basic productions of what could be known variously as the *Noon Universe* or *Meridian World* series – a future domain where communist ideals prevailed, where people befriended each other, where humanity met with an alien mind and determined that it was not so alien after all.

In 1965 they wrote *Monday Begins on Saturday*, about the evangelists of the Soviet "ITR" or technical class; the engineers, programmers, designers and other inhabitants of the scientific investigative institutes almost without number.

Monday and several later stories concluded the epoch of Strugatskij optimism. In the extended period of the following 25 years, the authors consequently presented to readers their all the less romantic but nonetheless powerful works.

In the interval of the 60s and 70s the authors wrote their key work, *Doomed City* or simply *Grad* (the novel would be published much later), where the fates of their own and the new generation were sharply reflected in the multilayered society of the *panopticum*. In *Doomed City* it is not even clear who is feared more, the Nazi Geiger, the Stalinist Voronin or the person who was a representative of the sixties generation and disenchanted with all, Katsman.

The brothers wrote *Ugly Swans*, having held it, like *Grad,* on the table for two decades. The anti-bureaucratic *Trojka Fairy Tale* interrupted the conditional continuation of *Monday*, which is not entirely read from far away with a smile. There also appeared *Roadside Picnic,* a production as provocative as it was full of despair.

"That I came into contact with the text and then tried to transfer it into cinematic medium, it is from one side a wild responsibility and difficult – period," declares actor and director Fyodor Bondarchuk [Son of Sergei Bondarchuk, film director of the 1960s production of Lev Tolstoj's "War and Peace"]. "And yet from the other, you remember about this as about the elation experienced when you succeed in coming into contact with great literature and completely magical names. And the creation of 'Worlds of the Strugatskis,' and what they left behind them – not only as literati brilliantly using the Russian language and forming the entire caste of the intelligentsia, they also explain what is happening here and now in this country, or what can occur in the world or in society at large, sometimes via [their] funny or even completely fantastic spaces or worlds, this certainly is their main attainment. And that, certainly, is a great, great loss."

Finally the authors return to the *Meridian World*, already it is far from being as joyous as it was 15-20 years ago. There the end justified the means. Terror forces one to go for murder. And humanity, which earlier did not shy away from influencing other civilizations toward progress, seems not to realize that with them, in the course of 100 years, a new race conducts detailed experiments.

One of the last collaborative productions of Arkadij and Boris – *Evil Overload*, finally revealed them as writers of social commentary, quite pessimistically looking at the future – beyond dependence on that somewhat bright one they [once] promised to make.

After the death of his brother Arkadij Strugatskij in 1991, Boris, in his words, "continued to guide a thick beam [boat] of literature with a two-hand tiller - but without a partner." Under the pseudonym S. Vititskij, he published the novels, *A Search of Predesignation, or the 27th Theorem of Etiquette* and the *Powerless Worlds*. For the full collection of compositions of the Strugatskis, the writer prepared *A Commentary for Proceeding*.

Though even at that, at times it had been difficult for the public to separate one brother from the other. It is said that Arkadij's daughter once heard how someone whispered behind her back, "There goes the daughter of the Strugatskij brothers."

Boris introduced a separate contribution to the development of Soviet science fiction. In 1974 he organized a significant seminar. It was not in the least that thanks to that seminar, readers found out about other Soviet science fiction writers Svyatoslav Loginov, Vyacheclav Rybakov and Aleksandr Tyurin. There they formulated the project *Time of the Scholars.* In that framework, well known science fiction writers developed the *Meridian World* and other domains of the Strugatiskijs. But from that moment, their writers' duet was no more.

In later years Boris related to the science fiction "reality"

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that they constructed skeptically. In one interview in the fall of 2011, he noted that within ten years the Strugatskij books would scarcely survive. And he added that, more than that, the universe was empty and free of intellect.

Both books of Boris Strugatskij, written without Arkadij, are full of disenchantment. The main hero of the first, *In Search of Predesignation*, determines that his fate safeguarded him from death, not his own efforts. The hero of the second, *Free of Supermen*, was powerless and unknowing, and even not wanting to resist surroundings or circumstance. In this story their aging, though almost immortal sensei ("teacher" in Japanese) is unable to teach anyone anything.

Ten years ago, on October 2, 2002, Boris Natanovich put in a place in his last book, "There is absolutely no time," the sensei said, even with some despair. He slumped into the seat, placed his hands on his knees, but now he bent again, almost having curled in the straps, "Absolutely," he repeated, "No time."

Since 1998 on the official Strugatskij Brothers website there is posted an interview with Boris. He answers questions from fans. The last comments of Strugatskij were published on November 4, 2012. "Patience, stability and a bit of divine grace," so he answered to the question of a reader about how to become a writer.

"I am unable to recover myself. We get poorer and poorer." Daniel Granin responded to the death of his colleague in the writing workplace.

Russian Prime Minister Dmitrij Medved called Strugatskij's death an uncompensated loss for Russian and world literature. "Boris Natanovich Strugatskij passed on from life, a great writer and thinker. A loss for our own and world literature," he wrote on Twitter.

The creativity of the Strugatskij brothers became the measure of changes in Russia, declared writer and chief editor of "Literaturnaya Gazeta," Yurij Polyakov. "Boris survived to see the results of these changes, and in the long run not all of them caused him to rejoice. But fact remains fact. Arkadij and Boris Strugatskij were influences on thought of the 60s, 70s and 80s," the Literaturnaya Gazeta editor reckons.

Compiled by *Nash Texas* (Russian for *Our Texas*) staff writers from material on the internet.

Roadside Picnic,
The Stalker,
Inhabited Island;
Film Directors
Tardovskij and Bondarchuk

One of the most immediately accessible artifacts of the Strugatskijs' work is the film adaptation of *Roadside Picnic* by director Andrej Tardovskij, the adaptation titled *The Stalker*. In fact, it can be seen in segments on YouTube, the first part a 63-minute segment.

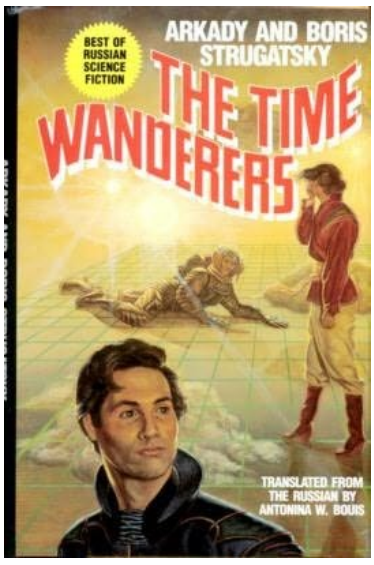
Alexander Tardovskij participated in the adaptation and then went on to a career in part in the west. But the film itself had some interesting elements besides. Beginning with a stark black and white sequence of initial scenes it introduces characters with handles like *Stalker*, *Writer* and *Professor*. The initial grim, bleak industrial future is much like a Twilight Zone set but in much more detail than what 1960s sound studios provided, adding desolate industrial landscapes to which generic humans cling like post barnacles. An expedition is launched into *The Zone,* where decades before a meteorite or something else fell. *The Zone* is a region where humans have capitulated and no one understands what goes on - unless it is an intuitive *Stalker* guide. It is cordoned off as with the Berlin Wall. Troops have vanished into its confines and never returned.

The expedition commences under conditions of stealth and pursuit and then emerges into a silent realm of forest vegetation and COLOR. This could be the inspiration of imitations such as the television series *Lost*. Who knows? As green as it is though, the landscape could have been a national park set aside for a battle like Kursk or Stalingrad with ruins and rusted military hardware dotting the undergrowth. The explorers head under the *Stalker's* guidance to a central ruin and a room. Dialogue is terse and generic, but the camera work is "contemplative." At this writing, I haven't sorted out how many YouTube installments go into this, but clearly after 60 minutes, the Stalker story is hardly done.

Among Americans who follow science fiction or Russian matters, I have found mixed reviews for this film. One of us on Horizons staff commented that with its director and writer pedigree *The Stalker* often appears on best film

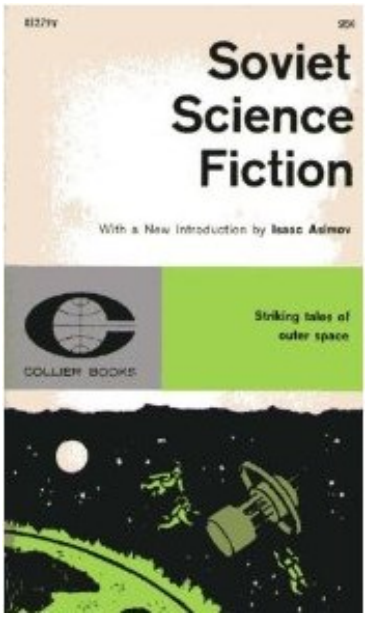
(Continued on page 40)

Above: Boris Strugatsky. Image credit: Wikipedia.



Above: Book cover image from Wikipedia citing fair use. The image is linked to the related Wikipedia web page.

Current Events



Above: Book cover image from Amazon.

Above: From the collection of Wes Kelly. The Worlds of the Brothers Strugatskij. Film Scenarios. The Stalker, A Case about a Murder (Alternate Title: Hotel of the Fallen Alpinist), Day of Eclipse, Without Armament, Beetle in the Anthill, The Magician, The Cloud, Machine of Desires.

(Continued from page 39)

lists, yet he wonders whether the Russian science fiction field had been as verdant as others in the 20th century. Another correspondent who shared the same Russian language training this writer received in military service reported that he did not like the film and preferred *Roadside Picnic* (*Piknik na Obochine*), the book on which it was based, recommending that in preference – if I liked science fiction.

As it turns out, the only Strugatskij anthology I have includes their screenplay for the same film, but not the original novel. Or does it? As can be seen from the cover, *The Stalker* is the lead story of a series of screenplays. [Translation: *The Worlds of the Brothers Strugatskij - Film Scenarios: The Stalker, A Case about a Murder, Day of Eclipse, Without Armament, Beetle in the Anthill, The Magician, The Cloud and Machine of Desires.* An Alternate title for *A Case about a Murder* was *Hotel of the Fallen Alpinist*.] The texts are not all written in conventional screenplay form as dialogs and stage notes as would be a Shakespeare play (for example, *Stalker*: Hello. *Scholar*: Good morning.), but in the prose form of novellas. And finally, in marginal notes, the Strugatskijs explain how the final story – not *Machine of Desires,* but *The Stalker* was the version that reached the screen.

"Several years ago there befell on us the honor of participating in the creation of the film, *The Stalker*. Director Andrej Arsen'yevich Tarkovskij initially took as the basis for his film the fourth chapter of our story, *Roadside Picnic*. However, in the process of working over nearly three years we arrived at a representation of the story with hardly anything that remained in common with the original other than the terms *Stalker*, *the Zone* and a mystical place where desires are enacted."

Stalker moves slowly to set the scene, but it does pose some interesting problems about genies in lamps. As the trio approaches the terraced site where things should come to a head I had to wonder if the *Professor* had blown his chance to have his wish fulfilled (a Nobel Prize in Physics as surmised by the *Writer*) by fretting about his lost rucksack full of fresh underwear. Then he carps back at the *Writer,* "And so you want to offer to humanity the treasure of your purchased inspiration?" *The Stalker* guide himself would abjure that, "I am not Fate but the hand of Fate." He claims that he is leading pilgrims in search of "happiness," which he hopes will not be bought at cost to others. Since reading the Russian is slow going as a non-native, it leaves time to wonder whether the Strugatskijs have a medieval everyman tale with the monikers. Or is it something else? After all, "academics" and writers were represented by powerful professional organizations in the Soviet Union. Were these viewpoints of Everyman or institutions being examined? Then near the precipice, in the dusty ante room, the *Professor* gets a phone call and a warning from his colleagues that the course he is on will finish him as an academic and destroy the hopes of millions. It turns out that there is more in his knapsack than clean clothes, his answer to the dilemma of allowing indiscriminate wish fulfillments.

Fyodor Bondarchuk, quoted above, directed a more recent Strugatskij adaptation to the screen, *Inhabited Island* (*Obytaemyj Ostrov*). Based on a *Meridian World* novel titled in English as *Prisoners of Power*, the film scored third biggest at the box office in former Soviet Union lands in 2009, and Bondarchuk received a best acting nomination and a *Golden Eagle* award for his portrayal. Among Strugatskij stories, *Inhabited Island* has more than the usual summary commentary online. A 22nd century protagonist from a utopian, socialist Earth finds himself marooned on a newly discovered planet with a humanoid society similar to that of his home planet in the mid 20th century, but suffering the effects of a recent nuclear war as well as exhibiting the forces that brought it on.

Forward
to the Socialist Future?

"You can have any color as long as it's black." – Henry Ford, summarizing the Ford Motor Company customer's choices.

"When I was growing up, I read 'Doomed City' three times." – Artem Ponomarev, space scientist and physicist, Universities Space Research Association (USRA), Houston, Texas USA.

Since Andrej Tardovskij also directed the Russian film *Solaris*, we could be lured to think that Stanislav Lem was a Russian science fiction writer as well. He was Polish and was read widely both in the west and Soviet bloc. What about the science fiction environment in Russia? What was the milieu from which the Strugatskij brothers sprang? We have more questions here than answers.

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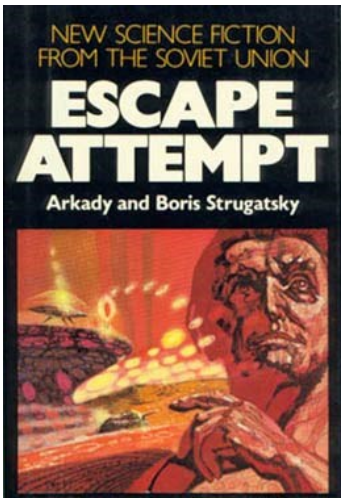
While Americans have had their own love affair with science fiction over the decades, there was less trade with Russian ideas in this realm than there has been with the space technology for which science fiction might have provided impetus here and over there. After Sputnik, at which point pulp science fiction magazines had already survived here for decades, Collier and Dell paperbacks published anthologies of Soviet science fiction, one edited by Judith Merrill, a New York science fiction editor and anthologist, others introduced by science fiction writers Isaac Asimov or Theodore Sturgeon. To read these books now in the wake of the Strugatskij brothers' careers would be like opening a time capsule related to them.

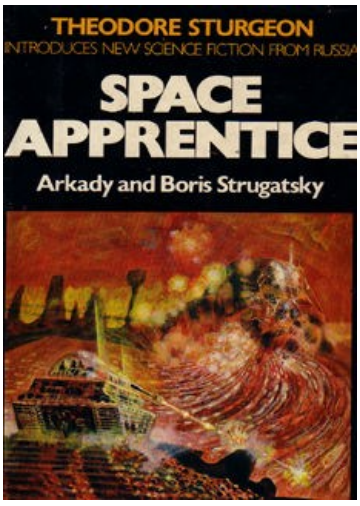
Aside from what might be included in the anthologies, we note that Lev Tolstoj's nephew Aleksandr wrote science fiction in the 1920s. He wrote about socialist Martians (*Aelita*). Rocket pioneer Tsiolkovskij wrote science fiction as well, if only to elaborate on theoretical astronautics. Soviet astronomers used science fiction as concept vehicles much like British author Fred Hoyle, though one suspects without as much thinly veiled invective against the establishment as in the latter's *The Black Cloud*. I submit, however, that traditional Russian or Soviet science fiction mused as much as it liked about products of research institutes or the consequences of launching Sputniks or rockets, but there had to be at least one constraint on their writing – and that was the official view of the future. With the notable exception of Yevgennij Zamyatin's *We*, written during the avante-garde 1920s period, the Strugatskijs and Count Tolstoy alike were obliged to discover communist utopias right down our temporal corridor within a century or so or when vehicles landed on advanced alien worlds.

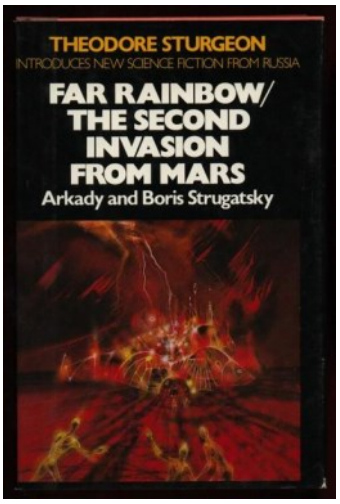
That constraint seems gradually to have lifted, or was pried loose by the creativity of Andrej and Boris Strugatskij.

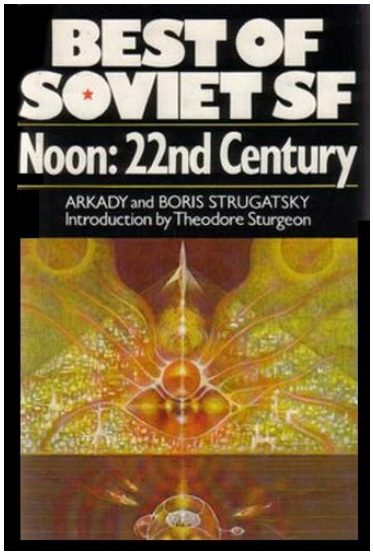
[END]

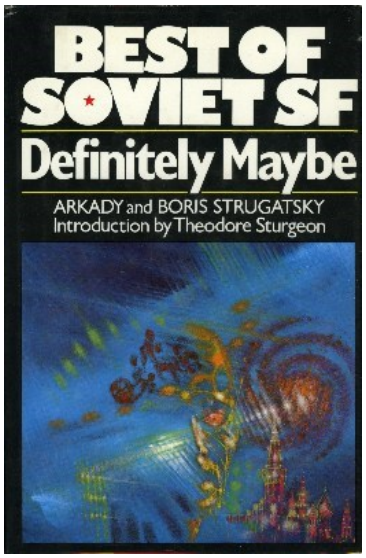
After reading in the Stalker the consequences of a meteor strike - or something else - it is hard not to note the significant Russian impact near Chelyabinsk of a large meteor or small asteroid in mid February 2013. To most it was already observed as coincidental with the passage of a small asteroid DA14 at about the altitude of GPS navigational satellites. Coincidental as that was, another Russian friend (Nikolai Gor'kavyj, co-author of Physics of Planetary Rings, 1994 Russian edition) once related to me how he had attended an early conference on planetary defense against asteroids near his laboratory at "Chelyabinsk - 70." In attendance from America in 1994 was physicist Edward Teller, there to explain how, when it came to asteroid defense, the hydrogen bomb could be the next century's Swiss army knife. Odds makers might reflect less on coincidence and more on whether Chelyabinsk was an intended target. For sure, though, events have become more akin to an Andrej and Boris Strugatskij story. [Wes Kelly]

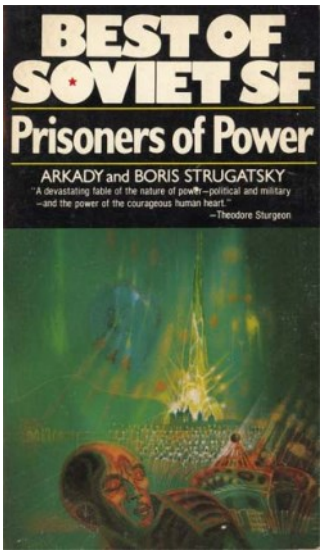












Above: Book cover images from Wikipedia citing fair use. Each image is linked to the related Wikipedia web page.

Current Events

NASA Signs Agreement for a European-Provided Service Module

NASA Press Release, January 16, 2013

Orion is going international.

An earlier page in this issue provides additional reporting, including a journalist's question about designing a system with multiple destinations.

Orion is going international.

NASA signed an agreement in mid-December for the European Space Agency (ESA) to provide a service module for the Orion spacecraft's Exploration Mission-1 in 2017.

- *Watch Orion's Exploration Mission-1 animation*
- *View images from Orion Partnership News Conference*
- *View the Orion Service Module Briefing Graphics*

Above: As part of a new agreement between the two space agencies, the European Space Agency will provide the service module for NASA's Orion spacecraft. Image credit: NASA.

When the Orion spacecraft blasts off atop NASA's Space Launch System rocket in 2017, attached will be the ESA-provided service module – the powerhouse that fuels and propels the Orion spacecraft.

"Space has long been a frontier for international cooperation as we explore," said Dan Dumbacher, deputy associate administrator for Exploration System Development at NASA Headquarters in Washington. "This latest chapter builds on NASA's excellent relationship with ESA as a partner in the International Space Station, and helps us move forward in our plans to send humans farther into space than we've ever been before."

Above: As part of a new agreement between the two space agencies, the European Space Agency will provide the service module for NASA's Orion spacecraft. Image credit: NASA.

The agreement primarily maps out a plan for ESA to fulfill its share of operational costs and additional supporting services for the International Space Station by providing the Orion service module and necessary elements of its design for NASA's Exploration Mission-1 in 2017.

There are three major components to the Orion vehicle: the crew capsule, which will carry four astronauts into space on crewed flights and bring them home for a safe landing; the launch abort system, which would pull the crew module to safety in the unlikely event of a life-threatening problem during launch; and the service module, which will house Orion's power, thermal and propulsion systems. The service module is located directly below the crew capsule and will contain the in-space propulsion capability for orbital transfer, attitude control and high-altitude ascent aborts. It also will generate and store power and provide thermal control, water and air for the astronauts. It will remain connected to the crew module until just before the capsule returns to Earth.

"This is not a simple system" said Mark Geyer, Orion Program manager. "ESA's contribution is going to be critical to the success of Orion's 2017 mission."

Exploration Mission-1 in 2017 will be the first integrated flight test with both the Orion spacecraft and NASA's new Space Launch System (SLS). It will follow the upcoming Exploration Flight Test-1 in 2014, in which an uncrewed Orion will launch atop a Delta IV Heavy rocket and fly to an altitude of 3,600 miles above Earth's surface, farther than a human spacecraft has gone in 40 years. For the flight test, a test service module is being built by Lockheed Martin.

Exploration Mission-1 in 2017 will launch an uncrewed Orion spacecraft to demonstrate the performance of the

(Continued on page 43)

Above: JSC2013-E-004070 (16 Jan. 2013) Seated on the dais for a January 16, 2013, joint National Aeronautics and Space Administration/European Space Agency Orion Partnership News Conference at the NASA Johnson Space Center are (from left) Public Affairs Office (PAO) Moderator Brandi Dean; William Gerstenmaier, NASA Associate Administrator for Human Exploration and Operations; Thomas Reiter, ESA Director of Human Spaceflight and Operations; Mark Geyer, Orion Program Manager; and Bernardo Patti, ESA Manager of International Space StationOperations. Image credit: NASA.

(Continued from page 42)

integrated SLS rocket and the spacecraft prior to a crewed flight. It will be followed by Exploration Mission-2, which will launch Orion and a crew of four astronauts into space.

"We have a lot to look forward to in the coming years with human exploration," Dumbacher said. "NASA is thrilled to have ESA as a partner as we set out to explore our solar system."

The images below were selected by Philippe Mairet, 3AF MP and Douglas Yazell, AIAA Houston Section.

Above: Orion and the Orion ESA Service Module. Image source: ESA. Image credit: NASA.

Above: Orion and the Orion ESA Service Module. Image credit: ESA.

Above: This mosaic of images from the Envisat satellite presents a unified Europe seen from space. Image source: Techno-Science. Image credit: ESA.

Above: An aerial view of the complete NASA Johnson Space Center facility in Houston, Texas. A portion of Clear Lake can be seen at the top of the view. Image date: August 10, 1989. Image source: Wikipedia. Image credit: Great Images in NASA (GRIN).

Calendar

All calendar items are subject to change without notice.

Section council meetings: email secretary2012[at]aiaahouston.org

Time: 5:30 - 6:30 PM usually
Day: First Monday or Tuesday of most months except for holidays.
Location: NASA/JSC Gilruth Center is often used. The room varies.

Recent Section events

21 February 2013: Dinner meeting. Guest speaker Leah Romero. Modeling & testing NASA Orion Capsule Parachute Assembly System (CPAS). Maiden name Olson (AIAA papers)

Upcoming Section events

Audiobook in work by Ted Kenny, NASA/JSC, Chair, AIAA Houston Section History technical committee, *Suddenly Tomorrow Came, A History of JSC*

Friday, May 17, 2013: AIAA Houston Section Annual Technical Symposium (ATS 2013). Location: NASA/JSC Gilruth Center. The publicity poster is presented on page 3. Time: Approximately 7:45 AM to 4:30 PM. See www.aiaahouston.org.

2013 Conferences www.aiaa.org (Events link)

2 - 9 March 2013 Big Sky, Montana, 2013 IEEE Aerospace Conference
6 March 2013 Tallahassee, Florida, Florida Space Day
8 March 2013 Washington, DC, Columbia Plus 10 Lessons Learned and Unlearned
12 - 13 March 2013 Sacramento, California, 2nd Annual California Aerospace Week
18 - 20 March 2013 DC, 11th US Missile Defense Conference & Exhibition - CANCELLED
19 - 20 March 2013 Washington, DC, 2013 Congressional Visits Day
22 - 23 March 2013 Park City, Utah, Space Weather Community Operations Workshop
25 - 28 March Daytona Beach, 22nd AIAA Aerodynamic Decelerator Systems Tech. Conf. & Co-located Conf's
25 - 27 March Saint-Louis, France, 3AF-48th Int'l Symposium of Applied Aerodynamics
26 - 28 March Westlake Village, CA, Civilian Applications of UAVs – A Calif. Perspective
28 - 30 March 2013 Salt Lake City, Utah, Region VI Student Paper Conference
3 - 5 April 2013 Milan, Region VII (Europe) Student Paper Conference
5 - 6 April 2013 College Park, Maryland, Region I Student Paper Conference
5 - 6 April 2013 Chicago, Illinois, Region III Student Paper Conference
8 - 11 April Boston, 54th Structures, Structural Dynamics & Materials & Co-located Conf's
8 - 9 April 2013 Raleigh, North Carolina, Region II Student Paper Conference
10 - 12 April Delft, Netherlands, EuroGNC 2013, 2nd CEAS Specialist Conference on GNC
10 - 13 April 2013 St. Louis, Missouri, Region V Student Paper Conference
15 - 19 April 2013 Flagstaff, Arizona, 2013 IAA Planetary Defense Conference
23 - 25 April 2013 Herndon, VA, Integrated Communications Nav. and Surveillance 2013
27 - 28 April 2013 Waco, Texas, Region IV Student Paper Conference
7 May 2013 Alexandria, Virginia, AIAA Fellows Dinner 2013
8 May 2013 Washington, DC, 2013 Aerospace Spotlight Awards Gala
13 - 16 May 2013 Los Angeles, CA, Reinventing Space 2013
15 - 17 May 2013 Mendoza, Argentina, Seventh Argentine Congress on Space Technology
27 - 29 May Berlin 19th AIAA/CEAS Aeroacoustics Conf. (34th AIAA Aeroacoustics Conf.)
27 - 29 May St. Petersburg, Russia, 20th St. P. Int'l Conf. on Integrated Nav. Systems
29 - 31 May Charlottesville, VA, Requirements for UTC and Civil Timekeeping on Earth: A Colloquium Addressing a Continuous Time Standard
6 June 2013 Williamsburg, Virginia, 2013 Aerospace Today and Tomorrow
12 - 14 June 2013 Istanbul, 6th Int'l Conference on Recent Advances in Space Technologies
17 - 19 June 2013 Washington, DC, 2013 American Control Conference
24 - 27 June San Diego, AIAA Fluid Dynamics and Co-located Conferences and Exhibit
14 - 18 July 2013 Vail, Colorado, 43rd International Conference on Environmental Systems
15 - 17 July San Jose, California, 49th AIAA/ASME/SAE/ASEE Joint Propulsion Conference & Exhibit & 11th International Energy Conversion Engineering Conference (IECEC)
11 - 15 August Hilton Head Island, SC, AAS/AIAA Astrodynamics Specialist Conference
12 - 14 August 2013 Los Angeles, California, AIAA AVIATION 2013
15 - 16 August 2013 Los Angeles, CA, 2013 Regional Leadership Conference
19 - 22 Aug. Boston, AIAA GN&C & Co-located Conf's & AIAA Infotech@Aerospace 2013

Horizons: published bimonthly by the end of February, April, June, August, October & December at www.aiaahouston.org.

Cranium Cruncher

Challenge

DR. STEVEN E. EVERETT, GN&C TECHNICAL COMMITTEE CHAIR

Last month a logic puzzle was presented in which the crew positions of the members of a former Shuttle mission were to be determined based on several provided statements. Based on these statements, it may be determined that Brown is the Commander, Clark is the MS2, Jones is the MS1, and Smith is the Pilot. In solving the puzzle, the reader should have also discovered that the list of names in order of decreasing chess ability is Smith (PLT), Clark (MS2), Jones (MS1), and Brown (CDR); and that, in addition to Jones (MS1) and Smith (PLT) being neighbors, so are Brown (CDR) and Clark (MS2).



This month you are a materials scientist who has obtained two identical samples from the same rock from the first Mars sample return mission. Your job is to determine the crushing strength of this Mars rock using a destructive test at your facility that can test at any of 100 discrete levels of pressure. If a sample fails the test, it is destroyed and cannot be used again, but if it does not break at a given level of test, it can be assumed that it was not significantly weakened and can be retested. What is the least number of tests that must be performed so that the highest level of pressure that can be sustained may be determined before having destroyed both samples?

Email answers at steven-dot-e-dot-everett at boeing-dot-com.

Membership

LISA VOILES, MEMBERSHIP CHAIR

Our current spreadsheet shows 1,088 members in AIAA Houston Section. Most list an organization, but 386 of them list no organization, though for some of those, we can deduce their affiliation by the organization name in their email address. Our Section attracts members mostly from NASA/JSC and its contractors, along with a large group from Texas A&M University. Two other universities in our Section with current or past AIAA Student Sections are Rice University and the University of Houston (UH), including the UH Clear Lake campus.

Membership grades include Members, Senior Members, Associate Fellows, Fellows, Honorary Fellows, Educator Associates and Student Members.

Our largest membership group from a university is a group of 162 people. The other two universities mentioned above have 17 and 12 members.

Outside of academia, our largest member group about 185 members. The closest member groups in size to that one are one with 58 members, followed by groups of the following sizes: 29, 28, 26, 17, 12, 10, 10, and so on.

Join AIAA! Please see our back cover for additional information.

History

TED KENNY, HISTORY TECHNICAL COMMITTEE CHAIR

Dr. Steven E. Everett, Norman Chaffee and Douglas Yazell volunteered to read for this audiobook project (below). If we can tie this in with the AIAA Houston Section Annual Technical Symposium (ATS 2013) of Friday, May 17, 2013, at NASA/JSC Gilruth Center (registration available vie SATERN), so much the better. A draft program document is now available on the ATS 2013 web page.

Since Skylab was launched on May 14, 1973, our Section is also working to attract Skylab presentations from NASA/JSC veterans at ATS 2013. One contact person for that is Dr. Albert A. Jackson IV, whose contact information is on our organization chart.

Since we will have recording equipment set up for our audiobook, we volunteered to help the NASA Alumni League JSC Chapter with oral history recordings, even if they are not transcribed in the near future.

Suddenly Tomorrow Came… A History of the Johnson Space Center, the Audiobook! (See page 22 of our July / August issue, a 76-page PDF file available in low (23 MB) or high (87 MB) resolution.) The original 1993 book is free (PDF with great art!) via NASA.

Section News

Night Pod Images Bring Earth to Light from Space Station

There is a reason the phrase "shooting in the dark" refers to things that are difficult to do -- and night photography is no exception. To account for low-light image scenarios, a photographer needs a steady tripod, but aboard the International Space Station, a traditional tripod isn't going to cut it. Thankfully, the European Space Agency, or ESA, developed NightPod for the crew's cameras.

This astronaut photograph of Liège, Belgium, at night was taken using the NightPod camera mount aboard the space station. The mechanism allows astronauts to capture images of the Earth at night with greater clarity and control than previously possible from orbit...

Above: This image, taken on December 8, 2012, with the ESA NightPod camera mount, shows the city of Liège, Belgium, as it appears at night from the vantage point of the ISS. Image credit: ESA/NASA.

Association Aéronautique et Astronautique de France (3AF)

Sister Section of AIAA Houston Section since 2007
Jumelée avec AIAA Houston Section depuis 2007

3AF Association Aéronautique Astronautique de France
Midi-Pyrénées

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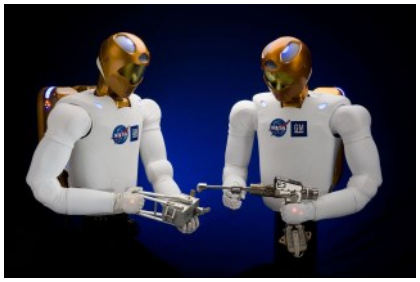
AIAA 2013 Space Automation and Robotics Award

Please see our back cover for a few more details from NASA about this 2013 AIAA award.

Section News

February 3, 2013- The AIAA Houston Section proudly wishes to congratulate the Robonaut2 team on this exciting award. Robonaut2 continues to inspire the youth and adults around the world, and is a prime example of high technology and a strong model for how governmental research entities can partner with industry in a mutually beneficial manner. Their team has overcome great challenges and rose to the occasion in ways that us outside their team may never fully understand, but will strive to duplicate in the future. Congratulations, the AIAA Houston Section is very proud of their achievements and this wonderful recognition of their efforts.

Sincerely,
Daniel Nobles, Chairman, AIAA Houston Section 2012-2013



Left: JSC2009-E-155295 (28 July 2009) --- NASA and General Motors have come together to develop the next generation dexterous humanoid robot. The robots – called Robonaut 2 – were designed to use the same tools as humans, which allows them to work safely side-by-side humans on Earth and in space. Image credit: NASA.

The American Institute of Aeronautics and Astronautics (AIAA)

AIAA Houston Section
Since 1962

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July 01, 2012 - June 30, 2013

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321-446-2776

Scholarship
Rafael Munoz / NASA
281-483-3427

Young Professionals
Tom Horn / Barrios
540-748-0442

Communications
Eryn Beisner / Barrios
281-244-0212

Webmaster
Irene Chan
323-393-5723

E-Mail
Ryan Miller/ Boeing
281-226-4430

Alan Sisson
281-235-2075

Christopher Davila / Barrios
281-244-8173

Larry Friesen / UHCL
281-334-5268

Shirley Brandt
713-542-9085

Sarah Shull / NASA
281-244-6441

Councilors
(2-year terms ending June 30, 2013)

Michael Martin / TAMU
979-220-5517

Alicia Baker / Baker Hughes
713-927-2044

Ellen Gillespie
281-682-3653

Matt Johnson / LMCO
281-333-6080

Melissa Kronenberger / SAIC
281-335-2270

Astrodynamics
Dr. Albert A. Jackson / Jacobs
281-483-5037

Automation and Robotics
Dr. Zafar Taqvi / Barrios
713-392-1280

Program Management & Integration
Dr. Satya Pilla / Boeing
832-858-3982

Extra-Vehicular Activity
Daryl Schuck/ Honeywell
281-532-5203

Guidance, Navigation, and Control
Dr. Steven E. Everett / Boeing
281-734-6284

History
Ted Kenny / NASA
281.244.0078

In-Space Imaging and Crew Observations
Dr. Kamlesh Lulla / NASA
281-483-5066

Space Operations
BeBe Kelly-Serrato / A-SCC
281-798-9060

Life Sciences, Space Processes, and Human Factors
Julie Mitchell / NASA
281-244-7417

Propulsion and Power Systems
Sheikh Ahsan / NASA
281-244-6826

Safety and Mission Assurance
Roger Kleinhammer / SAIC
281-335-2303

Systems Engineering
Gary Brown / Booz Allen Hamilton
713-933-6814

Space Commercialization
(Open)

International Space Activities Committee
Ludmila Dmitriev-Odier / USA
832-524-6307

Downloaded February 17, 2013

Executive Council Voting Members (20) are identified by:

Student Section News

Rice University AIAA Student Section Advisor:
Professor Andrew Meade, *meade[at]rice.edu*
713-348-5880, www.ruf.rice.edu/~meade/

Above: Image credit: Rice University.

Above: A recent panel discussion at Rice University was led by George Abbey of the James A. Baker III Institute for Public Policy. A Rice news link provides a short biography for each of the following panelists: Mark Albrecht, Leroy Chiao, Joan Johnson-Freese, Neal Lane, Eugene Levy and John Logsdon. The video was placed online. Eric Berger commented on this panel discussion later in the Houston Chronicle.

Above: Image credit: Rice University.

Student Section News
Please send inputs to Dr. Gary Turner, our College and Co-Op Chair. His e-mail address is: *collegecoop2012[at]aiaahouston.org*
His backup for this task is Editor Douglas Yazell: *editor2012[at]aiaahouston.org*
We publish most bimonthly issues at www.aiaahouston.org by the last day of each even-numbered month, and the submissions deadline is three weeks earlier. The November / December issue is an exception. It is published by December 10, not December 31.

Student Section News

The Texas A&M University AIAA student section started work on its web site for the new year as of August 10, 2012: http://stuorg-sites.tamu.edu/~aiaa/

Faculty advisor: Professor John E. Hurtado, *jehurtado[at]tamu.edu*, 979-845-1659.

Brian Freno '08 Chair	Bob Cline '13 Speaker Chair	Chris Greer Graduate Representative
Rahul Venkatraman '13 Vice Chair	Nhan Phan '14 SEC Chair	Nicholas Ortiz '13 Senior Class Representative
John Guthery '11 Secretary	Travis Dawsey Activity Chair	Alejandro Azocar '14 Junior Class Representative
Erica Lovig '13 Treasurer	Nick Page '16 Publicity Chair/ Webmaster	Logan Hodge '15 Sophomore Class Representative
		Jacob Shaw '16 Freshman Class Representative

Above: Nick Page of Tampa, Florida is the new (web site viewed on February 22, 2013) Publicity Chair / Webmaster. Image credit: Texas A&M University AIAA Student Section web site.

Above: In 1997, the school became home of the George Bush Presidential Library. Image credit: Wikipedia.

A view of the main campus, looking north from Kyle Field. At the center is the Academic Building with its copper dome.

Above: Statue of Lawrence Sullivan "Sul" Ross located in front of the Academic Building. Image credit: Wikipedia.

Student Section News

Please send inputs to Dr. Gary Turner, our College and Co-Op Chair. His e-mail address is: *collegecoop2012[at]aiaahouston.org*
His backup for this task is Editor Douglas Yazell: *editor2012[at]aiaahouston.org*
We publish most bimonthly issues at www.aiaahouston.org by the last day of each even-numbered month, and the submissions deadline is three weeks earlier. The November / December issue is an exception. It is published by December 10, not December 31.

Section News

AIAA Houston Section Annual Technical Symposium (ATS 2013)
Notes about a Few of the Submitted Abstracts
Event Date: Friday, May 17, 2013

Astrodynamics

DR. ALBERT A. JACKSON IV, TC CHAIR

AIAA Houston Section Astrodynamics Technical Committee Chair Al Jackson will organize a session as usual.

He will also submit an abstract about the Horizons series of reprints, Man Will Conquer Space Soon! This famous series of space articles appeared in the weekly magazine Collier's in eight issues from 1952 to 1954. The contributors included the organizer, Wernher von Braun. Horizons is the first to reprint this page by page in high resolution. We are reprinting these eight sets of articles in the original order in eight consecutive issues of Horizons. The fourth of these eight sets of articles starts on a later page in this issue of Horizons.

Al Jackson is also one of the organizers of the Skylab sessions for this event. These sessions celebrate Skylab's 40th anniversary. Skylab launched on May 14, 1973. One of the Skylab presenters will be Ken Young.

Climate Change

DR. GERALD R. NORTH, TEXAS A&M UNIVERSITY

Dr. Gerald R. North will make a presentation of at least 45 minutes about the essential story of climate change. He will include time for questions and answers at the end of his presentation. A few biographical notes from the university web site:

North and his research group are interested in climate change and the determination of its origins. We work with simplified climate models which lend themselves to analytical study, estimation theory as applied to observing systems, and the testing of all climate models through statistical approaches. Often all three themes are combined for a particular application.

Over a period of 30 years, North and associates have studied a hierarchy of simplified models known as Energy Balance Climate Models (EBCMs). Both linear, nonlinear, and stochastic versions of these models have been shown to be good analogs to the real climate of the surface temperature field including the two dimensional seasonal cycle and the field of fluctuations. These models have very interesting properties from mathematical as well as physical points of view. For instance, multiple solutions occur for the present external conditions and their stability properties are amenable to analysis. Stochastic versions of the models are useful analogs to more comprehensive models making them a useful laboratory for preliminary analyses before expensive experiments are performed.

INCOSE

INTERNATIONAL COUNCIL ON SYSTEMS ENGINEERING

The local INCOSE Chapter did a great job last year with two 75-minute morning sessions and two 75-minute afternoon sessions, filling that entire track for the day's event. They might not have quite that many presentations this year.

Skylab 40th Anniversary

KENNETH A. YOUNG AND OTHERS

Ken Young's NASA-related oral histories and biography are online. ATS 2013 penciled in two afternoon 75-minute sessions for the Skylab 40th anniversary presentations. The first Skylab launch date was May 14, 1973.

Analysis of Voyages: Charting the Course for Sustainable Human Space Exploration

DR. KUMAR KRISHEN, NASA/JSC

The future of human presence in space beyond Earth orbit has been the focus of NASA strategic planning efforts for more than four decades. In the recent past, a report titled "Voyages, Charting the Course for Sustainable Human Space Exploration" was issued by NASA. This report identifies cis-lunar space, near-Earth Asteroids (NEAs), the Moon, and Mars and its moons as the destinations for future human exploration. The strategy for this exploration is based on capability-driven approach. This approach is used to identify capabilities that need to be developed to enable multiple human missions. This presentation will summarize the highlights of the NASA report. It will critically examine the implications of the destinations on technology development and capability enhancement. The objective is to show what developments should receive priority in the future to enable safe and affordable human space missions. It will identify a set of questions that can lead to a successful prioritization of the technology development. In this context each destination and technology identified in this report will be discussed and rationale for the technology prioritization provided. (Views expressed in this presentation are not necessarily those of NASA.)

Above: Launch date December 19, 2012. Soyuz TMA-07M crew patch. Image source: collectSPACE. Image credit: NASA / Roscosmos / Soyuz crew of TMA-07M.

Above: Launch date October 23, 2012. Soyuz TMA-06M crew patch. Image source: collectSPACE. Image credit: Roscosmos / Evgeny Tarelkin.

Who's on ISS now? (February 25, 2013)

Expedition 34, November 2012 - March 2013

- Oleg Novitskiy
- Kevin Ford (Commander)
- Evgeny Tarelkin
- Roman Romanenko
- Chris Hadfield
- Tom Marshburn

Right: The crew members of the Expedition 34 mission put together the following description of their patch: "The outer border of the Expedition 34 patch takes the mold line of a crew transfer or generic resupply vehicle which will form our bridge to the orbiting outpost throughout the second half of its operational lifetime. Inscribed inside in gold is a craft symbolizing future extra-terrestrial landers that will someday open other celestial destinations to human exploration. Our Sun, which enables the miracle of the only known life in our universe, radiates above the rich and colorful orb of Earth. Its 15 rays represent the countries of the International Space Station (ISS) Partnership whose foresight and sacrifice have enabled the first small steps into our universe. The ISS in flight represents the dedication, ingenuity, and cooperation amongst the thousands and thousands of workers around the globe who have successfully designed and built a wonder of our modern world. The distant stars, like those visible in our night sky, beckon us to come further into the depths of space. 'Off the Earth. . . For the Earth' - Our acknowledgement of the responsibility and commitment to work diligently for all inhabitants of planet Earth." Image credit: NASA / Expedition 34 crew.

Staying Informed

AIAA Daily Launch

Leading the News

"Legendary" Astronauts, Staff Meet For Apollo 17 Anniversary, amid "…little enthusiasm for a planned mission to an asteroid…"
The Pensacola (FL) News Journal (12/16, Ghioto, Johnson) reported Eugene Cernan, the commander of Apollo 17, John Glenn, and other "legendary Mercury, Gemini and Apollo astronauts and mission control staff gathered Saturday at the National Naval Aviation Museum in Pensacola for an unprecedented reunion" to celebrate the Apollo 17 anniversary. Those at the "Salute to the Pioneers of Space" event "steered clear of controversy surrounding burgeoning criticism of NASA amplified by recent reports that shows a space agency in flux with little enthusiasm for a planned mission to an asteroid and a lack of mission focus."

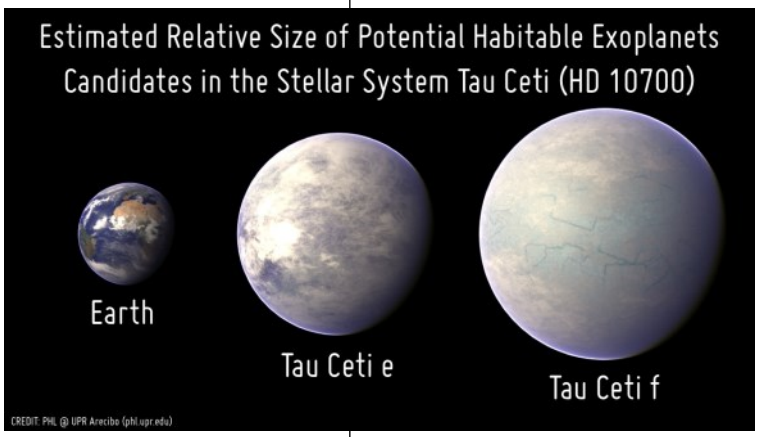
collectSPACE (12/14, Pearlman) noted also Friday was the 40th anniversary of when Apollo 17 left the moon.

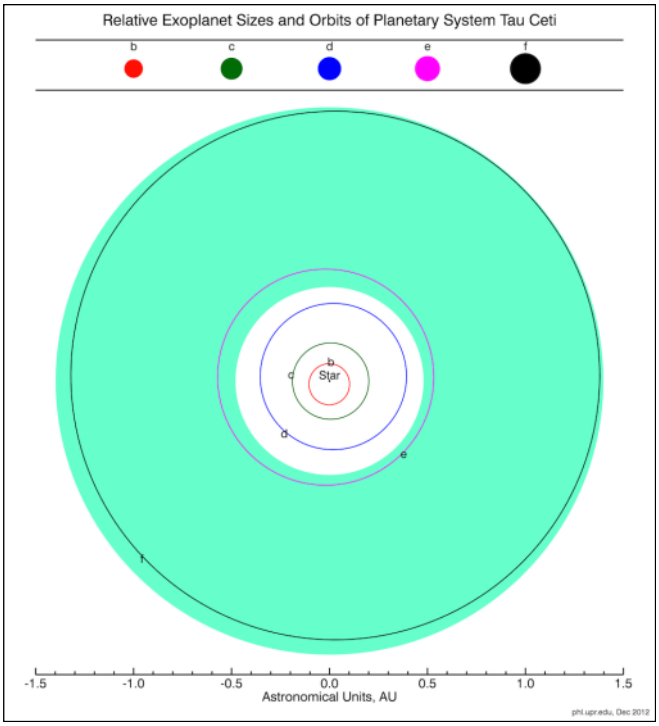
Two student videos from NASA/JSC interns! NASA Johnson Style! (Take-off on Psy Gangnam style music video):
iSS (lowercase intended):
http://www.youtube.com/watch?v=vPHM-rR4wN4
NASA Johnson Style:
http://go.nasa.gov/ZmRigo (World's best music video– see screen capture images. More than 2,000,000 hits on YouTube in the first week.)

Two Nearby Habitable Worlds Around Tau Ceti?
http://phl.upr.edu/press-releases
Dec 19, 2012 2:07 AM by Abel Mendez Torres [updated Dec 19, 2012 6:46 AM]
From the Planetary Habitability Laboratory, University of Puerto Rico at Arecibo

See our related article earlier in this issue.

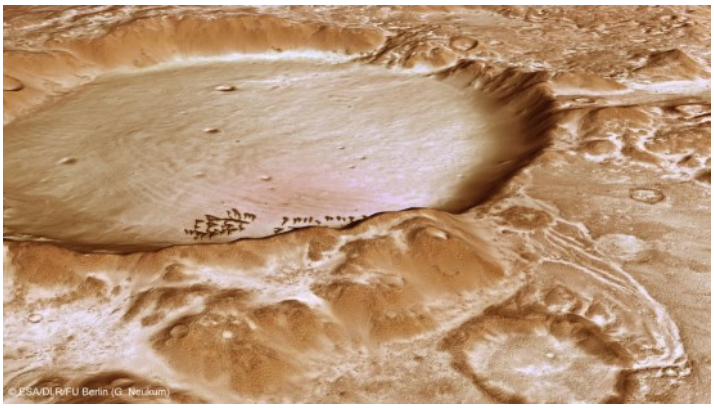
Toumi et al. 2012 announced the possibility of five super-Earth exoplanets around Tau Ceti (aka HD 10700). They also suggested that one of these planets is within the habitable zone of the star. However, their data suggest that not only one but two are candidates for habitable planets.





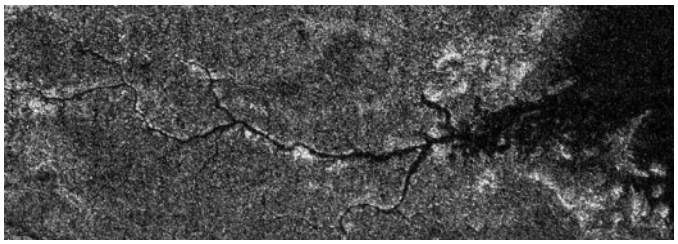
Editor's note: Tau Ceti is a star about 12 light years from Earth and similar to our Sun, but a bit dimmer.

Staying Informed



Above: Perspective view of Charitum Montes. This computer-generated perspective view was created using data obtained from the High-Resolution Stereo Camera (HRSC) on ESA's Mars Express. Centred at around 53°S and 334°E, the image has a ground resolution of about 20 m per pixel. This perspective view shows the breach on the northern side of the 50 km-wide crater that dominates the image. Dendritic patterns link to completely filled-in craters that flank the larger one, within which a small sand dune follows the contours of concentric sedimentary pattern. This image was taken during revolution 10778 on 18 June 2012. Credits: ESA/DLR/FU Berlin (G. Neukum)

Below: Dec. 12, 2012 Cassini Spots Miniature Nile River on Saturn Moon



Above: This image from NASA's Cassini spacecraft shows a vast river system on Saturn's moon Titan. It is the first time images from space have revealed a river system so vast and in such high resolution anywhere other than Earth. The image is rotated 90 degrees clockwise. Image credit: NASA.

Above: "How Will People be Able to Survive in Space?" The artist is Loup Mairet, age 9. He lives in France. His father Philippe is part of our Horizons team and part of our team working on our sister section relationship between AIAA Houston Section and 3AF MP. Although Loup did not know it, in this issue of Horizons, our Collier's reprints from 1952 - 1954 start a series called Man's Survival in Space.

IMAV2013

International Micro Air Vehicle Conference and Flight Competition

Toulouse, France, September 17-20, 2013

www.imav2013.org

ENAC — École Nationale de l'Aviation Civile in Toulouse, France

Air Force Research Laboratory of the United States of America

MAV Research Center — Micro Air Vehicle (MAV) Research Center

ISAE — Institute Supérior de l'Aéronautique et de l'Espace in Toulouse, France

AIRBUS — Airbus, an EADS Company

Collier's 1952-54

Man Will Conquer Space Soon! (1952-54)

DOUGLAS YAZELL, EDITOR

The Horizons Collier's Team

Douglas Yazell, Editor
Scott Lowther, Aerospace Projects Review (APR)
Dr. Albert A. Jackson IV
Ron Miller, Black Cat Studios
Melvin Schuetz, bonestell.com
Frederick Ira Ordway III
John Sisson, Dreams of Space
Arthur M. Dula
Shirazi Jaleel-Khan

Quite a few more people make these articles possible, including the Horizons team listed on page 2. Thanks to all involved!

We continue reprinting this superlative series of space articles on the following pages. Collier's used eight issues of the weekly magazine from 1952 to 1954 to publish these articles. We are on schedule as we work to use eight consecutive issues of Horizons to reprint *Man Will Conquer Space Soon*! This is our fourth installment.

This February 28, 1953 issue of Collier's used the front cover, a paragraph about the cover on its table of contents page (That paragraph is presented on the next page.), and nine consecutive pages (no advertisements) in the middle pages of that issue. We follow roughly that same format in this issue.

Scott Lowther keeps our copies of all of the scanned pages we need to reprint this entire series of two years (1952 to 1954) and about 89 pages. Scott allowed us to use his five issues of Collier's, the original magazines. John Sis-

(Continued on page 55)

	"Man Will Conquer Space Soon!" in 8 Issues of the Weekly Magazine Collier's 1952-54	Cover Image	Page Count	
1	March 22, 1952: Man Will Conquer Space Soon! What are we Waiting For? pp. 22-23, The Editors Crossing the Last Frontier, pp. 24-29, 72, 74, Dr. Wernher von Braun A Station in Space, pp. 30-31, Willy Ley The Heavens Open, pp. 32-33, Dr. Fred L. Whipple This Side of Infinity, pg. 34, Dr. Joseph Kaplan Can We Survive In Space? Pp. 35, 65-67, Dr. Heinz Haber Who Owns the Universe? Pp. 36, 70-71, Oscar Schachter Space Quiz Around the Editor's Desk, pp. 38-39	Yes	25	
2	October 18, 1952: Man on the Moon Man on the Moon, p. 51, The Editors The Journey, pp. 52-58, 60, Dr. Wernher von Braun Inside the Moon Ship, pg. 56, Willy Ley	Yes	11	
3	October 25, 1952: More About Man on the Moon The Exploration, pp. 38-40, 44-48, Dr. Fred Whipple & Dr. Wernher von Braun Inside the Lunar Base, pg. 46, Willy Ley	No	10	
4	February 28, 1953: World's First Space Suit Man's Survival in Space, 10 Contributors & 3 Artists, edited by Cornelius Ryan pp. 40-41 Picking the Men, pp. 42-48	Yes	10	This issue
5	March 7, 1953: More About (Continuing) Man's Survival in Space Testing the Men, pp. 56-63	No	8	
6	March 14, 1953: How Man Will Meet Emergency in Space Travel Concluding Man's Survival in Space: Emergency! pp. 38-44	Yes	9	
7	June 27, 1953: The Baby Space Station: First Step in the Conquest of Space Baby Space Station, pp. 33-35, 40, Dr. Wernher von Braun with Cornelius Ryan	Yes	6	
8	April 30, 1954: Can We Get to Mars? / Is There Life on Mars? Is There Life on Mars? pg. 21, Dr. Fred L. Whipple Can We Get to Mars? pp. 22-29, Dr. Wernher von Braun with Cornelius Ryan	Yes	10	

Above: Man Will Conquer Space Soon!, a series of articles from 1952 to 1954, from the weekly magazine Collier's. Source for most of the table: Wikipedia, Man Will Conquer Space Soon!, an article first written by John Sisson.

(Continued from page 54)

son (Dreams of Space blog) scanned two of his copies for Horizons, and Ron Miller (Black Cat Studios) scanned one of his copies for Horizons.

Once all of the required scanned pages were in Scott's possession, he cleaned up the scans where required. That was a big job.

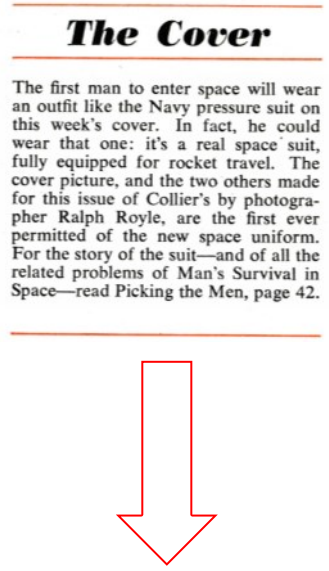
Every two months our Horizons team publishes another issue, knowing that for eight consecutive issues, we have this excellent content from 1952 to 1954 for Horizons. It is not often the volunteer team of AIAA Houston Section takes on such a long term project.

In addition to the Horizons team noted on page two of every issue, we have our Horizons Collier's team to thank, as noted on the prior page. They contribute most of our advertising for now, and we thank them again for that.

The Collier's series in eight issues of that magazine presented a spectacular first issue, followed by two issues titled *Man on the Moon*, three issues titled *Man's Survival in Space*, an issue titled *The Baby Space Station*, and finally an issue titled *Can We Get to Mars? / Is There Life on Mars?* It was tempting to present all three issues titled *Man's Survival in Space* in this issue of Horizons, shortening time span for this all volunteer task. For now, we stay on course, with eight consecutive issues of Horizons devoted to reprinting the contents of those eight issues of Collier's.

Once we complete our reprint series in this manner, we can reprint the entire Collier's series in a single publication, another ambitious volunteer project already in work.

Collier's 1952-54

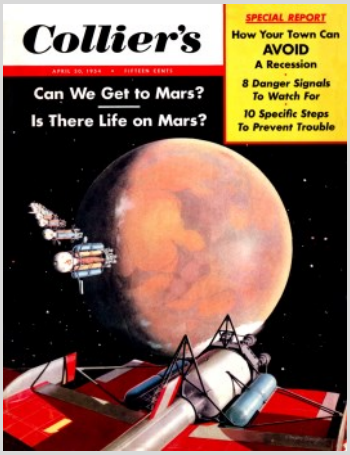


The Cover

The first man to enter space will wear an outfit like the Navy pressure suit on this week's cover. In fact, he could wear that one: it's a real space suit, fully equipped for rocket travel. The cover picture, and the two others made for this issue of Collier's by photographer Ralph Royle, are the first ever permitted of the new space uniform. For the story of the suit—and of all the related problems of Man's Survival in Space—read Picking the Men, page 42.

Issue 3 of 8:
The cover image
is not related to
Man Will Conquer
Space Soon!

Issue 5 of 8:
The cover image
is not related to
Man Will Conquer
Space Soon!



Above: Image credits: Scott Lowther, with help from other Horizons Collier's team members.

Collier's

FEBRUARY 28, 1953 • FIFTEEN CENTS

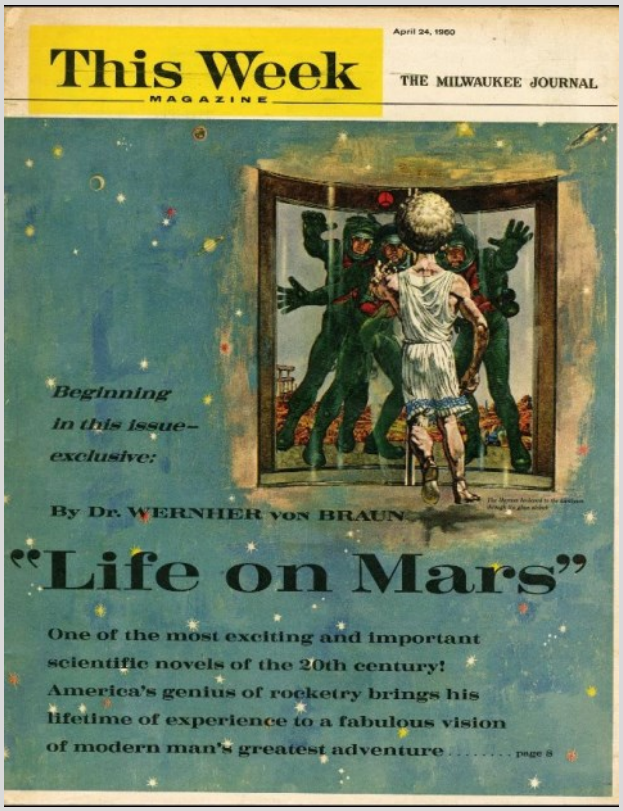
EXCLUSIVE

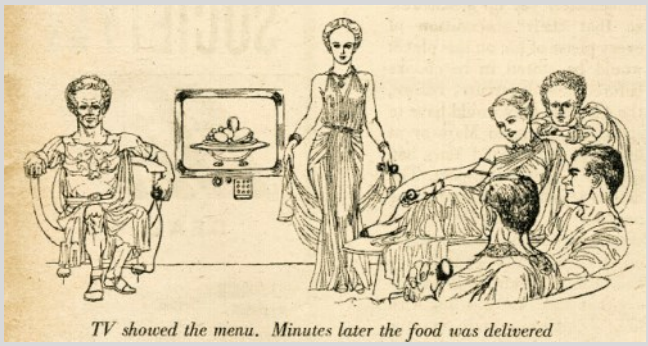
WORLD'S FIRST SPACE SUIT

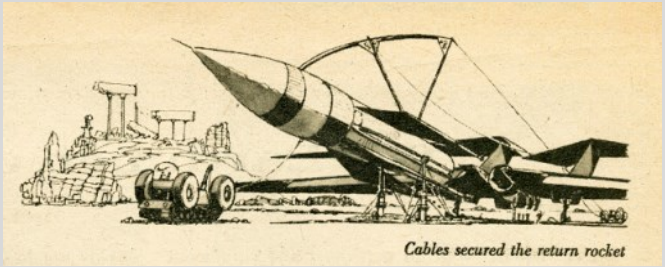
How and Where We'll Use It

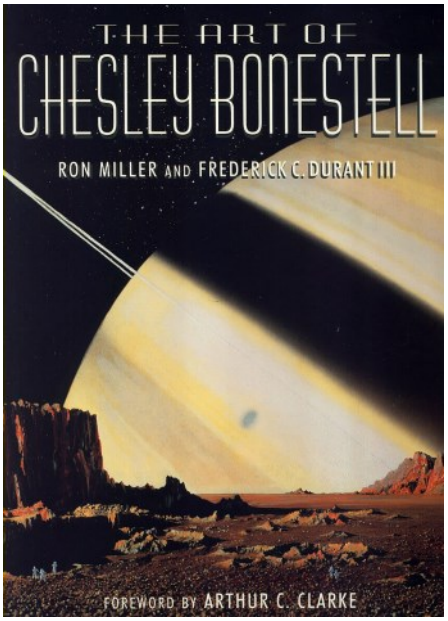
Dreams of Space
Books & Ephemera

Non-Fiction Children's Books about Space Flight from 1945 to 1975
http://dreamsofspace.blogspot.fr




TV showed the menu. Minutes later the food was delivered


Cables secured the return rocket

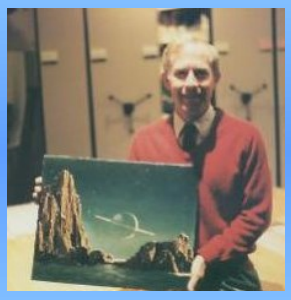


Award winner Ron Miller & Black Cat Studios

Ron Miller, winner of the 2002 Hugo Award (World Science Fiction Society) for Best Related Work: The Art of Chesley Bonestell

The Chesley Bonestell Archives of Melvin H. Schuetz

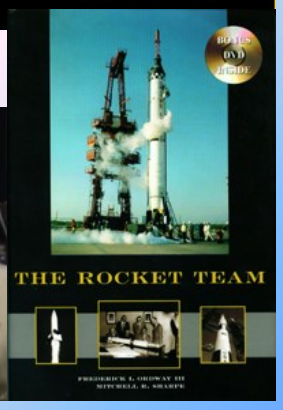
www.bonestell.com



A former satellite controller in the U.S. Air Force and private industry, Melvin H. Schuetz has researched and collected publications from around the world containing Bonestell's art for more than four decades. His book, A Chesley Bonestell Space Art Chronology, is a unique reference bibliography containing detailed listings of over 750 publications which have included examples of Bonestell's space art.

Space scientist and well-known author of visionary books on spaceflight. Ordway was in charge of space systems information at the Marshall Space Flight Center from 1960 to 1963 and before that performed a similar function for the Army Ballistic Missile Agency. For many years he was a professor at the University of Alabama's School of Graduate Studies and Research. However, his greatest contribution has been to the popularization of space travel through dozens of books that he has authored or coauthored. He was also technical consultant to the film 2001: A Space Odyssey and owns a large collection of original paintings depicting astronautical themes. Ordway was educated at Harvard and completed several years of graduate study at the University of Paris and other universities in Europe.

www.cgpublishing.com



Frederick Ira Ordway III

Co-Author with Mitchell R. Sharpe of The Rocket Team

Dreams of Space, Books & Ephemera

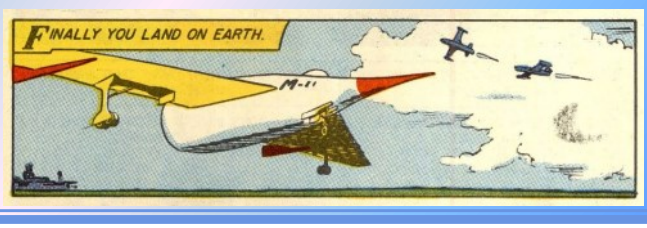
Non-Fiction Children's Books about Space Flight from 1945 to 1975

http://dreamsofspace.blogspot.fr

Classics Illustrated were comic books intended to educate as well as entertain. They often were fictional "classic" books in comic book form such as Moby Dick. They also had a special series called "The World around Us." These were non-fiction comic books about topics of interest.

Classics Illustrated. Illustrated by Gerald McCann, Sam Glanzman and John Tartaglione. The Illustrated Story of Space (80 pages), 26 cm, softcover.

Contains illustrated stories on training for space, the first rocket to the Moon, the history and use of the rocket, the launch of Vanguard 1 and the construction of a space station. "The World Around Us" (#5) January 1959.



Man's Survival

We can build the rocket ships, but success depends on

CONTRIBUTORS

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Col. DON FLICKINGER, M.D.
Director of Human Factors, USAF's Air Research and Development Command, Baltimore

WILLY LEY
Rocket expert and historian, cofounder of original German Rocket Society

Capt. JAMES E. SULLIVAN
USNR, Director, Airborne Equipment Division, Navy Bureau of Aeronautics

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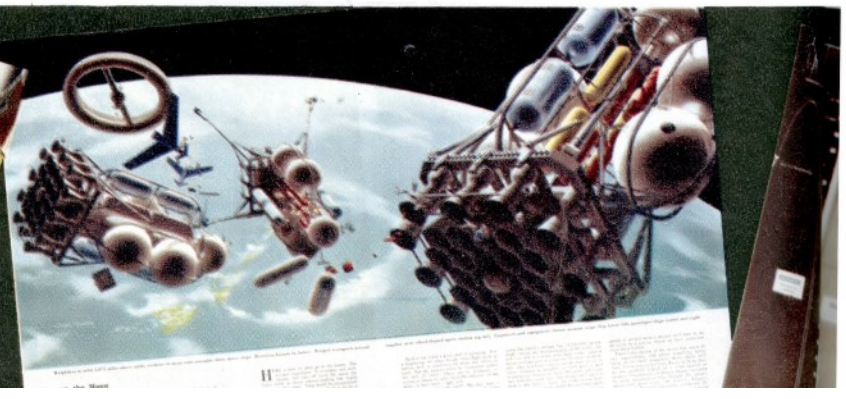
Dr. JAMES A. VAN ALLEN
Head, Department of Physics, State University of Iowa

Dr. HUBERTUS STRUGHOLD
Head, Department of Space Medicine, USAF's School of Aviation Medicine, Randolph Field, Texas

Dr. DONALD W. HASTINGS
National Psychiatric Consultant to the U.S. Air Force; Head, Department of Psychiatry, University of Minnesota Medical School

ILLUSTRATED BY CHESLEY BONESTELL, FRED FREEMAN AND ROLF KLEP




VON BRAUN


MULLER

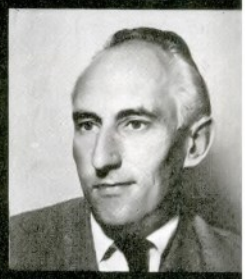

FLICKINGER


LEY


STRUGHOLD


HENRY

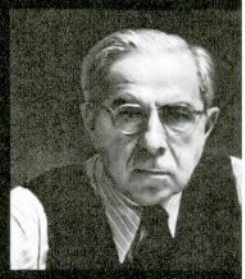

H. HABER


F. HABER


VAN ALLEN


HASTINGS


SULLIVAN


BONESTELL


FREEMAN


KLEP

in Space

Edited by
CORNELIUS RYAN

the most complicated mechanism of all: the human body

WHO will fly tomorrow's rocket ships? Must the crews be limited to expert mathematicians, astronomers and physicists or can we use the caliber of men who fly today's jet planes? Will space travelers be tall, short, fat or thin?

We have the answers to these questions. Scientists, physicists and aero-medical doctors can specify the type of person suited for the job of conquering space and how the crews will be selected and trained. There's a good reason why our scientists can confidently make these estimates: they are hard at work at this moment to put man into space. So are certain branches of the Navy and Air Force.

While the government has not officially announced a space program, a score of the nation's colleges have quietly received U.S. contracts to investigate specific space flight problems. Some aircraft manufacturers are busily engaged in top-secret space research. One has the prototype of a space station on its drawing boards.

The Air Force and Navy are also vitally concerned with what kind of man we'll need for space flight. Today's jet fighters, bombers and experimental rocket-powered craft are flying faster and higher than ever before. They are speeding along the very borders of the upper atmosphere and, at these great altitudes and high speeds, crews are meeting virtually the same environmental hazards which exist in the void of space. In short, modern aviation is rapidly growing into space flight. We have been preparing for the inevitable.

Just as we protect man in atmospheric flight, so will we safeguard man in space. In the last few years, Air Force and Navy scientists and doctors, working together, have developed pressure suits which can be used in upper-altitude flight. We can use the Navy's version in space. The time has come to start thinking how we want the rocket ships built.

In the prejet age, airplanes were built with only performance in mind. Little thought was given to the men who had to fly them. Pilots and crews were expected to adjust automatically to the finished machines. Modern aviation medicine, as it becomes space medicine, has one rule of thumb concerning upper-altitude or space flight: man—human needs—must be considered before a single blueprint for an aircraft or rocket ship leaves the drawing board. Says Major General H. G. Armstrong, Air Force Surgeon General: "Physics and its allied sciences identify the specific physical hazards . . . Medicine determines the human reactions to these hazards . . . Engineering and its allied sciences design and develop the necessary protective equipment."

We must construct our rocket ships around the men who must fly them.

But who are they?

The story of the selection and training of the crews who will operate tomorrow's rocket ships begins on the following pages, as the first of a three-part series. So many branches of science are involved in discussing the human factor of space flight that Collier's asked a distinguished panel of aero-medical scientists, physicists, radiologists and engineers to contribute to the series. Because their fields of study interlock and overlap, their papers have been combined into one continuous narrative.

It is an important narrative. The success of any program to reach space depends on the machines, it is true. But even more largely it depends on the most delicate, most indispensable of all instruments—man himself. ▲▲▲

Man's Survival in Space

Picking the Men

Can ordinary, healthy people visit space? They can—the Navy's new space suit points the way—but we'll look for special qualities in the pioneers. The physical and psychiatric examinations will be so tough that of every 1,000 trainees who can meet the strict entrance requirements only five will make the grade. Here's how we'll choose

WE COULD send man into space right now, this year. And he *would* survive. Without any particular discomfort, either. He'd face hazards—from blood-draining acceleration to blood-boiling low pressure, from cosmic rays to extreme temperatures—but these are hazards we know we can beat.

Most, in fact, have been overcome by a single development, never before publicly disclosed: the completion of the Navy's new pressure suit, tailored for space travel. The Navy space suit, pictured on this week's cover and on the opposite page, carries its own atmosphere—oxygen, pressure, air conditioning. It can be worn for long periods, and permits complete freedom of movement. It was developed with space problems in mind.

You could wear it to the moon tomorrow.

We know that we can build the rocket ships to take us into space (Collier's, March 22, October 18 and 25, 1952), and we know we can protect their crews. All we have to do is find the right men —and women—to make the trip.

It would be foolish to solve all the mechanical problems and then run a risk of human error. So we must choose space crew members carefully—so carefully that Colonel Don Flickinger, the doctor who is one of the top Air Force experts on what the body must endure in flight, makes this rough estimate:

Of every 1,000 persons who can meet the initial rigid educational, physical and age requirements for space training, only five will ever enter space—just enough for one rocket-ship crew.

What are the standards those 1,000 must measure up to? And what are the problems that will wash out 995 of them?

An applicant for space training must be old enough to have mature judgment; whizzing through the blackness of space at speeds up to 18,000 miles an hour, facing situations men have never known before, he must make decisions fast—and right. But he must not be so old that he can't stand the rigors of space travel: catapultlike acceleration which may increase his weight ninefold, followed within minutes by complete weightlessness; tremendous demands on his endurance; the need for near-perfect reflexes and co-ordination.

Of the 11 scientists taking part in Collier's three-installment symposium, six contributed to the article Picking the Men: Drs. Heinz Haber, Donald W. Hastings, Hermann Muller and James A. Van Allen; Air Force Col. Don Flickinger and Navy Capt. James E. Sullivan

He must be well-educated, so he can absorb the fairly advanced scientific instruction that will equip him for rocket travel and life in space. As part of his training, he will receive a thorough grounding in both practical and theoretical engineering, medicine, astronomy and navigation.

He can't be too tall or too short and stout. Such people often have poor control of their blood circulation, which makes them more subject to fainting, and more susceptible to variations in temperature and other hazards of space.

The best prospective crew members will be between twenty-eight and thirty-five years old, and of medium build: five feet five to five feet eleven inches tall, and weighing perhaps 10 per cent less than the average for their height. And they will have college degrees, or the equivalent as measured by examination.

How about women? Chances are, they'll be sought after for some space crew jobs. Not as pilots, perhaps, but as radio and radar operators—jobs requiring a high degree of concentration under difficult circumstances. In industry, women have indicated that they can perform monotonous and tedious tasks hour after hour without undue loss of efficiency. We need people like that in space travel. The physical and educational qualifications will be about the same for women as for men, except that the women may be shorter and lighter.

Those are the applicants. Now they must be culled; the unfit must be ruthlessly eliminated to minimize the risk of personnel failure.

The first and most severe test will be a medical-psychiatric examination which will cut the original 1,000 down drastically. The physical exams, which will be in two parts, are expected to weed out no less than 880 of the starters, and the psychiatric test 60 more.

Why so tough? Because even minor organic or emotional defects will be tremendous handicaps; what we're looking for are people with specific physical attributes and unusually stable personalities.

The space crew members will not be supermen. But they will be well-adjusted individuals in excellent health, with a few special aptitudes to equip them for the special problems of space. Those special aptitudes are important; they explain why even men as carefully picked and well-trained as jet pilots probably wouldn't all make the grade as space pilots.

At altitudes above four miles, there's virtually no air; an unprotected man would swiftly suffocate. From eight to 12 miles up, the region of extreme low pressure starts; from that level on into infinity, the body fluids would boil if not protected (first the saliva bubbles, then the skin balloons in places, under the pressure of water vapor rising beneath it, and finally the blood starts to churn).

Then there's the temperature problem. A man speeding spaceward passes within moments through wild temperature variations—from moderate temperatures on the ground to 67 degrees below zero F. at an altitude of eight miles and then into a region where temperature as we know it no longer exists: a man exposed to the full blast of the sun's ultraviolet rays would roast in an instant, while objects hidden from the sun would lose heat until —if in the shadow long enough—their temperature would drop close to absolute zero.

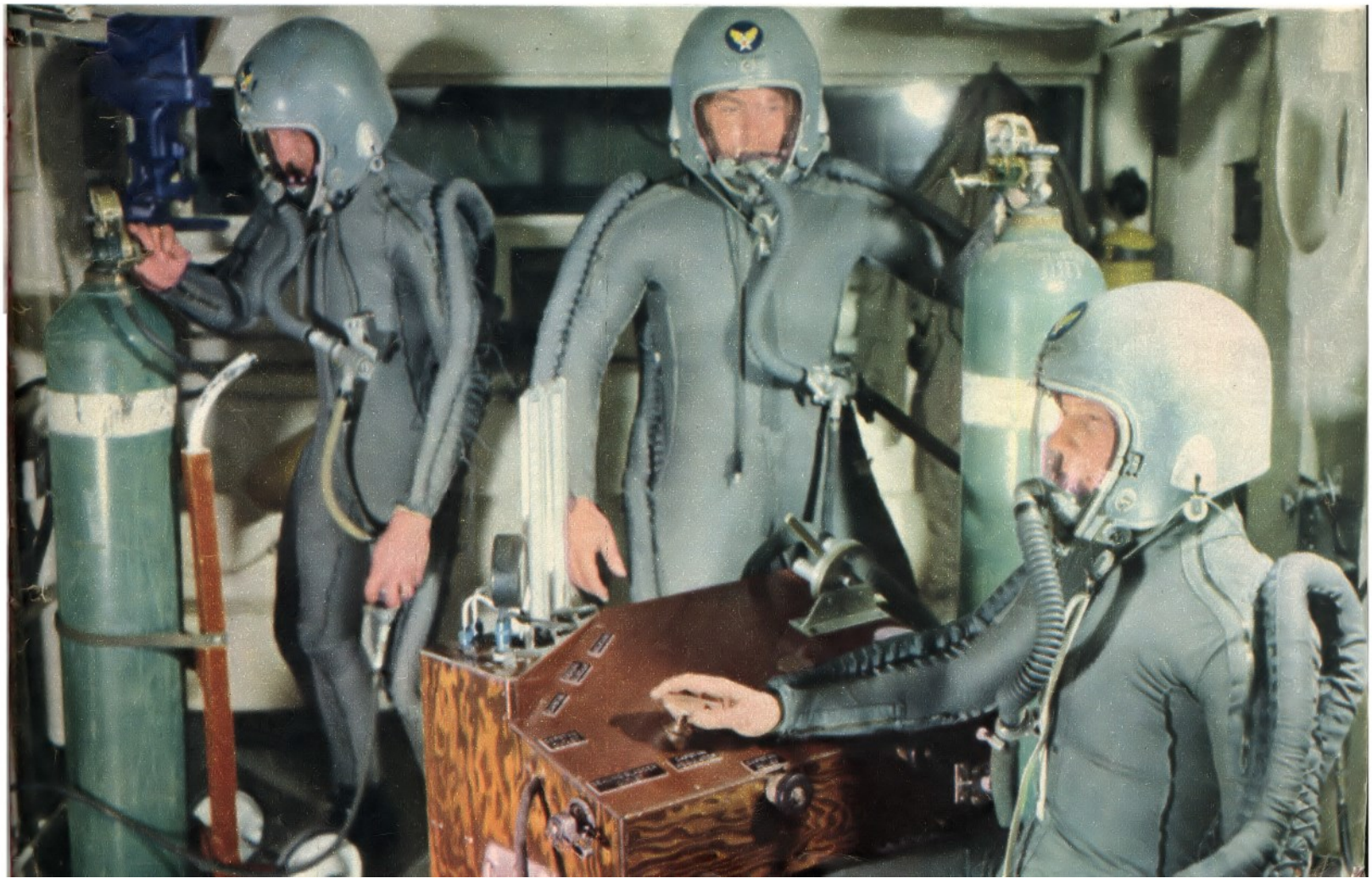
In a region so unlike the environment we've always known, there's only one way to protect life: bring our environment with us. From the moment he enters space until the time he leaves it, man will

Like Navy, the Air Force has been thinking of space problems. This is Air Force emergency pressure suit, developed by Dr. James Henry, shown undergoing pressure-chamber test. Suit inflates automatically as cabin pressure drops, does not protect hands or feet. Main contractors were David Clark Co., Bendix Aviation Corp., and International Latex Corp.

PHOTOGRAPHS BY RALPH ROYLE

New Navy space suit is a one-piece affair, with helmet hinged to the shoulders. It has been tested to altitudes of 63,000 feet and still higher tests are under way. Many details of the suit are top secret

Suit permits great freedom of movement. It was designed by Carroll P. Krupp, of Findlay, O., 35-year-old self-taught Goodrich engineer, under the direction of U.S. Navy's technicians. It would work on the moon



A typical space crewman: not too tall, short or stout—and emotionally stable. For some

live inside a protective envelope of his own making, a high-pressure chamber, either within the sealed cabin of his rocket ship or living quarters, or within the sealed casing of his space suit. The new Navy suit—developed under the direction of Captain James Sullivan of the Navy Bureau of Aeronautics—will do the trick.

The Navy space uniform, which is being used experimentally under heavy guard at the National Air Matériel Center, Philadelphia, actually does more than solve the major problems which occur at extreme low pressure. It solves many of the bothersome minor problems, too.

How does a man move around when he's encased in a high-pressure balloon (which is what a space suit is)?

The natural tendency of a pressure-filled suit is to become rigid and unyielding; how can the wearer bend his arms and legs? How can he use his fingers? Turn his head?

The rubber Navy suit permits almost complete mobility by means of a variety of devices, most of them still top secret. Semirigid accordion pleats allow movement of the important body joints: shoulders, elbows, knees. Ingenious wrist joints permit rotation of the hands. Man in space will find that his fingers wriggle almost as freely as they might in a conventional thick glove—and with a sensitivity of touch that's almost completely lacking in normally gloved hands. The helmet is attached at the shoulders, and is so built that a man's head can move comfortably within it. The suit has special slide fasteners which seal the suit as they close.

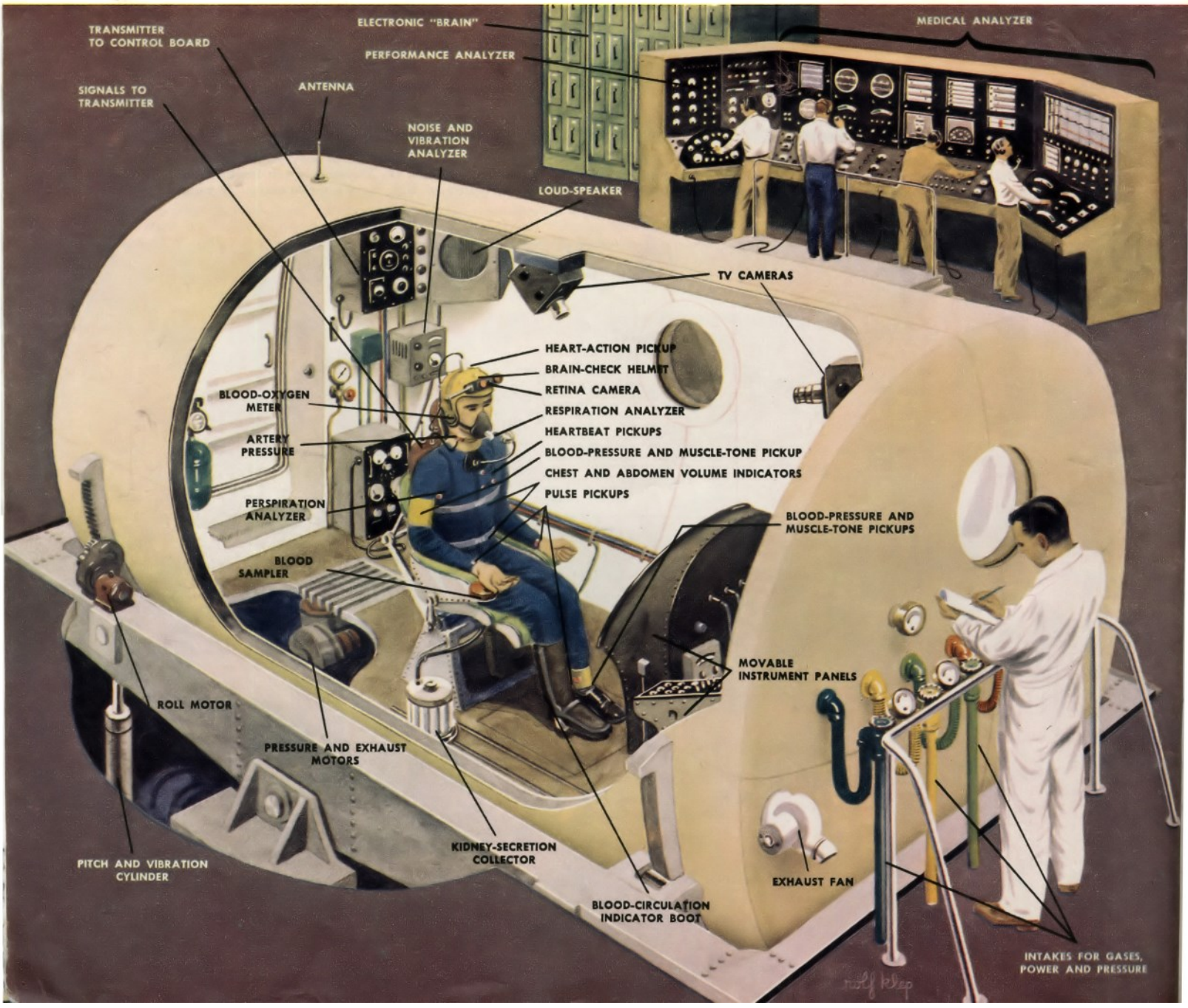
Refinements such as these explain, in part, why the suit cost about $225,000 to develop. (It was made by the B. F. Goodrich Company, using fabricating techniques developed by the David Clark Company and hardware by the Firewel Company and Bendix Aviation Corporation. In production—it will be made in three sizes—its price will drop to about $2,000 per suit.) But the real significance of the uniform is the near-perfect protection that it gives against the big hazards: lack of oxygen, blood-boiling low pressure and temperature variation.

If the crew member gets all that protection, why worry about special aptitudes? Couldn't any individual live comfortably in an artificial atmosphere almost identical to the earth's?

The answer is no. Some people simply can't endure man-made atmosphere. Scientists aren't sure why, although it seems certain that the reasons are largely psychological. Pressure-chamber and pressure-suit tests show that a certain percentage of any group will fold up under conditions which other people don't mind at all. And a few can take low pressures that would knock out almost anyone else.

Those are the few we want.

Suppose a rocket-ship cabin develops a leak. It's possible; no equipment is perfect. The crew members will be so well-versed in emergency procedures that the leak probably will be plugged in a few moments—but for those few moments all personnel aboard the ship will have to cope with an environ-



ment far different from the earth's. It's then that our extreme care in the selection of crew members will pay off.

Obviously, we'll want to test all applicants in pressure chambers. We've been doing that for years with aircraft crews and trainees. But more than that, we'll check our 1,000 for certain physical properties. A person whose circulatory system is under excellent control will be far better equipped to exist for long periods on relatively little oxygen, and in the cramped quarters of a rocket ship, than one with unpredictable variations in blood pressure.

A crew member whose nervous and circulatory systems react swiftly and efficiently to outside temperature changes will be affected only slightly by variations which might incapacitate someone else.

Problems of a Space Vehicle's Crew

Before a space vehicle even leaves the 120-mile-high atmosphere which surrounds the earth, its crew members will have confronted all the problems of low pressure, plus a couple of others: cosmic radiation and ultraviolet radiation.

Ultraviolet radiation doesn't trouble us; it could be dangerous to an unprotected man, but our crew member will never lack the protection of cabin walls, space suit fabric and tinted glass.

Cosmic rays, the minute, ultrahigh-speed, radioactive particles which whiz constantly through the upper atmosphere and space, have been an object of dread for many years—principally because most people know so little about them.

Scientists know enough, however, to be pretty certain of two facts:

First, they aren't as bad as they've been described, not bad enough to constitute a real danger.

Second, their relative harmlessness is a source of vast satisfaction to space scientists, because there's no practical way of protecting space travelers from them. The reasons will be discussed later in this article.

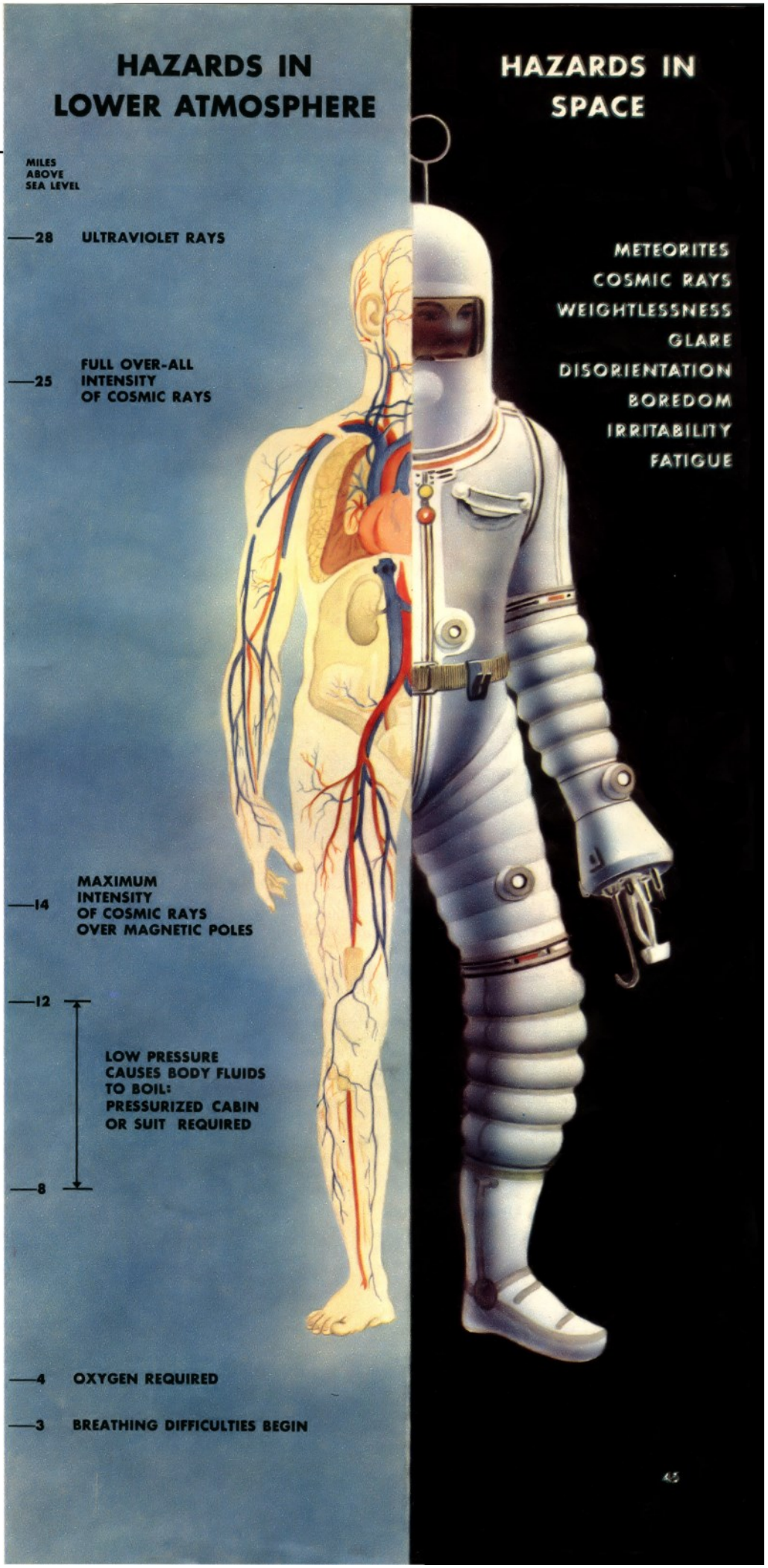
Above the atmosphere, only one more physical hazard confronts the space traveler: meteorites. There again, there is no built-in safeguard in the human body. Medical men are counting on the engineers to provide sufficient protection. But there are other problems we must meet.

In aviation training, the greatest number of men are eliminated because of faulty reactions or poor judgment under actual flight conditions. It isn't easy to provide flight conditions in rocket-ship training; obviously, we can't send potential crew members into space in a multimillion-dollar space vehicle as part of our selection process. Yet it's much more important to weed out the unfit in a

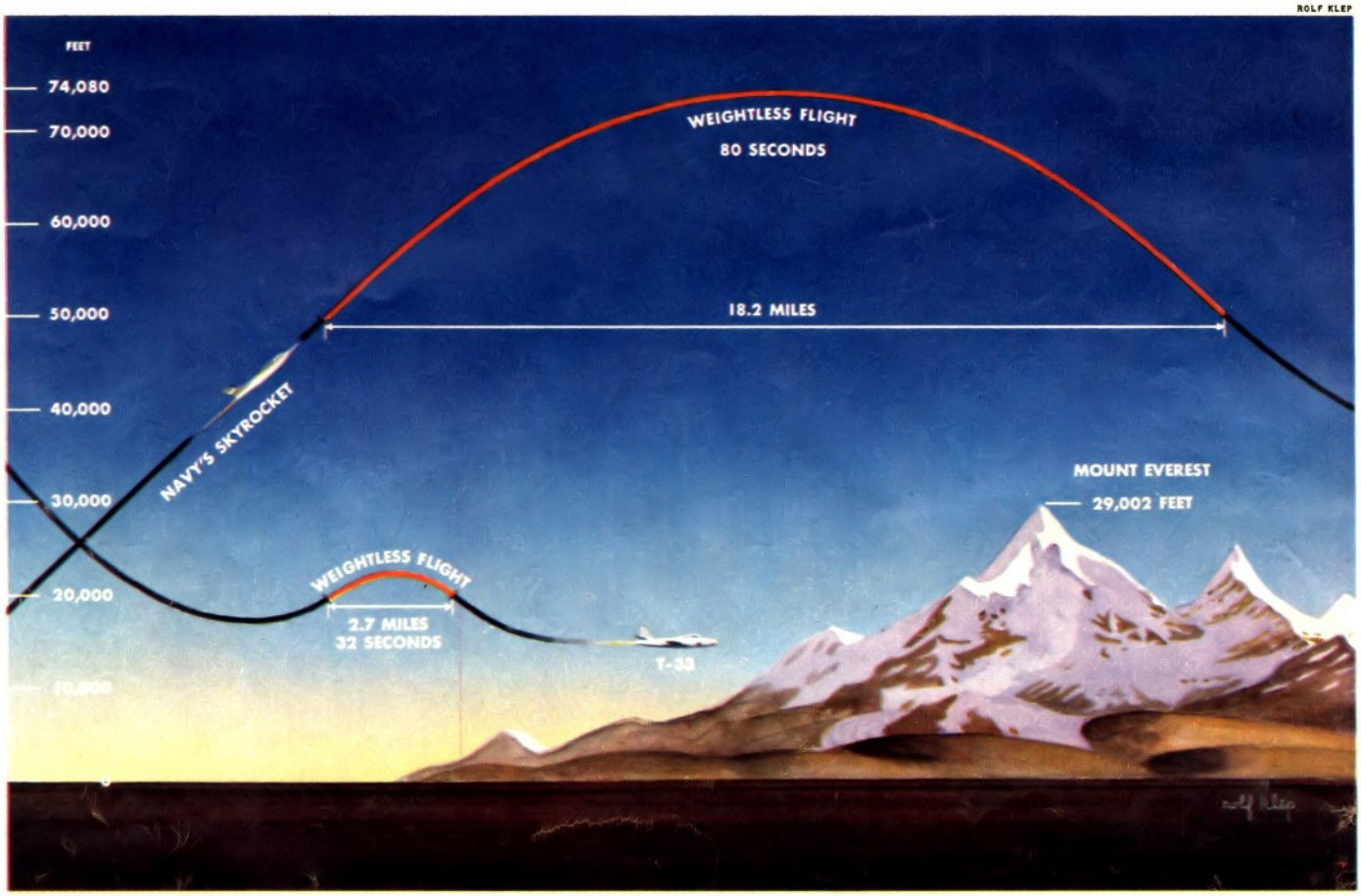
This device will test candidate's ability to take stresses of space. Roll motor and pitch cylinder will rock and shake chamber; noise will be piped in; pressure and composition of atmosphere will be varied. Prospective crew member will be required to solve problems set into instrument panels by remote control. As he works, electrodes, cardiographs and other instruments attached to his body will record how various organs function under the strain. The heart, brain, eyes, perspiration, blood, muscles all will be checked separately, and technicians and surgeons will see results on analyzer panels. One TV camera will be fixed on candidate, other on the instrument boards

In lower atmosphere, the hazards at left menace unprotected man. Even crewman in space wearing pressure suit will be subject to dangers noted on right. But none is a serious obstacle to an assault on space today

DRAWINGS BY ROLF KLEP



Science is breaking down the barriers. The Navy suit licks the low-pressure hazard;



This shows the method devised by Dr. Heinz Haber for achieving weightless flight in a modern high-velocity airplane. Plane dives to pick up speed, then pulls up and flies in humplike arc. Pilot is weightless while in arc. Bottom diagram shows flight path of T-33 jet trainer which made the first such flight, with crack Air Force test pilot Maj. Charles Yeager at the controls. Upper line indicates how our fastest rocket plane, the Douglas Skyrocket, flying above 10-mile altitude, can lengthen arc, almost triple period of weightlessness

space program than in aviation training. What can we do?

We can copy the stresses of rocket flight on the ground. In fact, we can do better: right now we can make the tests far more concrete than those used in aviation, which depend largely on personal observation and opinion.

The trainee will be seated within a small, elaborately instrumented, boilerlike chamber. The inside pressure can be lowered; the chemical composition of the atmosphere varied; the temperature adjusted. The testing flight surgeon can vibrate the whole contraption violently, pipe noises into it—or conduct any of the tests in combination.

Candidate Given Electronic Checkup

The candidate will, in effect, be wired for sound and radar. His suit will be the center of a network of wires. Television and X-ray cameras will hover over him. Electrodes, cardiographs and other electronic devices will check his pulse, blood pressure, breathing rate, skin temperature, internal temperature, perspiration and the oxygen content of his blood. Every section of his heart and brain will send out its own signals to a control board outside the chamber—so the surgeons will be able to check not only for malfunctioning of specific organs, but for the co-ordination of the physical machinery as a whole.

The air intake of the candidate's lungs and the chemical composition of the exhaled air will be analyzed to see how efficiently his lungs work at various pressures. The movement of blood through his body will be followed as a check on the contraction and relaxation of his blood vessels.

Outside the chamber, the watching doctors will see a picture story of the candidate's life processes in action. They will be able to evaluate the reports transmitted from the chamber, to see if some organs are working too hard, to see if integration between the brain, heart, lungs and circulation is all it should be.

By the time he steps out of the chamber, the candidate won't have a physical secret left; of the original 1,000 only 120 men and women will remain. And the chamber tests may disclose a few psychological secrets, too.

Psychology is an extremely important consideration in weighing a candidate's ability to cope with life in space. An individual living in the confinement of a rocket ship or space station experiences many emotional strains: the confusing absence of familiar guidepoints, like the horizon, to show him what position he's in (there's no vertical or horizontal in space); the tremendous monotony of empty scenery and cramped quarters; the irritating presence of the same few people over long periods; mental fatigue caused by the need for constant, unrelenting alertness to the problems of a completely new environment.

Can harassed modern man endure the additional mental stresses of space life?

He can, according to Dr. Donald W. Hastings,

U.S.A.F.

Maj. "Chuck" Yeager, first man to be weightless, found experience confusing

the top Air Force consultant on psychiatric problems. Some men will do better than others, though, and we'll want the best of the lot. We'll get them by putting each candidate through an exhaustive psychiatric check, probing into his subconscious (possibly with the aid of harmless drugs and hypnosis), and testing him for such characteristics as ingenuity, intelligence, judgment and courage.

When our psychiatrists and psychologists finish with the candidates, the 120 survivors of the physical tests will have been whittled down to 60.

Even so, no test psychologists can devise will measure adequately an individual's ability to adjust to the one remaining problem of space: weightlessness.

A space vehicle or space platform traveling around the earth at a certain distance and speed (1,075 miles and 15,840 miles an hour, for example) will exactly counterbalance the effect of the earth's gravity. Occupants of such craft will float in space. It's likely to be a disturbing experience; until crew members get used to it, they may suffer from dizziness and nausea.

Some people might never get used to it. How can we comb them out? We certainly can't simulate weightlessness on earth, can we?

No, but we can simulate at least one *effect* of weightlessness, and, using jet planes, at certain speeds we can achieve brief periods of weightlessness in the air.

Zoologists know that when small iron filings replace the sand grains which are normally in the inner ear, or balancing organ, of a crayfish, and a magnet is held above the filings, the crayfish shows about the same kind of confusion humans can expect from weightlessness. His organ of equilibrium responds to the impulse of the magnetized filings with a wrong guess: up becomes down, and the crayfish flips onto its back. A similar experiment, both harmless and painless, might be tried on larger animals. We might learn a lot about weightlessness in humans from such research.

An Experiment in Defying Gravity

But obviously, the most effective way to judge the effect of weightlessness is to watch someone who's experiencing weightlessness. We're now able to do that, using a method devised by Dr. Heinz Haber, astronomer and physicist, who was formerly with the Air Force Department of Space Medicine. A number of men have already tried Haber's method, and have defied gravity for periods of up to 30 seconds. Here's how it's done:

A cannon shell is weightless from the moment it leaves the muzzle until the instant it strikes the target. Haber proposed imitating the arc of a shell with an airplane.

Air Force Major Charles Yeager tried it. Yeager, the first man to fly faster than sound, went up in a jet trainer and put it into a long dive, to pick up speed. Then he pulled up and pushed over into a roller-coaster arc, to simulate a shell's flight. From the moment he started the arcing trajectory, he was weightless. A pencil lying on the jet's instrument panel rose majestically into the air and hovered there, providing Yeager with a course indicator. (When the freely floating pencil rose too high, Yeager adjusted his flight to keep the pencil stationary; in that way, he was able to stay within the weightless arc.)

How did it feel?

Strange, Yeager reported. First there was a falling sensation, but that didn't bother him much, since he was securely fastened to his seat. But then his head began to "grow thick," and he had trouble orienting himself. A few seconds later, he had the impression that he was spinning around slowly; he couldn't say in what direction. It was, he said, like sitting on a big ball which was slowly rotating in all directions at once. After 15 seconds, thoroughly confused, he pulled out of the arc.

Several other men have tried the Haber method since Yeager's attempt. Some have been weightless for half a minute—and none have reported the effects that disturbed Yeager. Their solution: by staring at a fixed point on the plane's instrument panel, they keep a sense of balance and perspective. Additional flights, under controlled conditions, should supply more answers to the problem of weightlessness—especially if they're made in one of the latest experimental rocket models. If the Navy's rocket-propelled Douglas Skyrocket, our fastest plane, were used for such an experiment, weightlessness could be achieved for almost a minute and a half.

There's just one more possible psychological hazard to space travel: an unreasoning fear of cosmic radiation. The simplest answer is to give our space candidates a complete course in cosmic rays, to prove that they need not be afraid.

Theoretically, cosmic rays are capable of doing the same kind of delayed damage to humans as that done by X rays or radium or atomic-bomb rays: a person who absorbed too great a dosage might produce strange physical changes—or mutations—in his descendants.

But the damage is insignificant unless we absorb an overdose. About 25 years ago, massive doses of X rays were administered to a species of fruit fly which breeds so rapidly an entire generation can be produced in a few weeks. Within a short time, weird freaks turned up among certain of the descendants—some without eyes, others with strangely shaped wings and legs, or with legs where their feelers should be, or with unusual coloration. These mutations were passed on to later generations, proving that the damage had been permanent.

The fruit-fly tests were dramatic and, to many people, fearsome. They should not have been. It wasn't easy to produce the freakish insects. Of hundreds of flies subjected to massive X-ray doses, only a relative few passed on marked changes to their offspring, and it sometimes took generations of breeding to turn out a real monster. Even

Cosmic rays, X rays act alike. Normal flies like one above, heavily X-rayed, had freakish descendants below: tiny-eyed, yellow, short-winged, wingless, mottle-eyed or dark-bodied. But men won't find such heavy dosage in space

PHOTOGRAPHS BY INDIANA UNIVERSITY

ROLF KLEP

One expert checked cosmic-ray intensity 53 miles up

genes which sustain a near-killing dose of radiation seldom produce outlandish abnormalities. Changes, yes; freaks, rarely. Dr. Hermann J. Muller, one of the world's outstanding authorities on the subject, puts it this way: If a human were exposed to all the radiation his system could stand, enormous numbers of his descendants would have to be closely examined before a single really abnormal person turned up.

How much cosmic radiation would a man absorb in space?

The Air Force is conducting experiments to help answer that question, sending fruit flies aloft in balloons to altitudes between 50,000 and 100,000 feet. But even now we know the answer in general terms. Last year, Dr. James A. Van Allen led an expedition to the waters off Greenland for the Office of Naval Research to measure the intensity of cosmic radiation over the polar area, where the earth's magnetism attracts an especially high concentration of the electrically charged particles. Small plastic balloons were sent aloft from the Coast Guard cutter Eastwind with slender rockets suspended beneath them. After 55 minutes, timing devices launched the rockets, and Geiger counters on each rocket measured cosmic intensity all the way up to 53 miles.

The greatest concentration—about 170 particles per second striking an area the size of a man's hand—was found at altitudes between 14 and 25 miles. There are sure to be more particles than that at a great distance from the earth, because the earth itself shielded Van Allen's Geiger counter from particles which might otherwise have struck from below. Van Allen estimates, on the basis of his findings, that a three-inch square 1,000 miles above the earth might be struck by about 700 cosmic particles a second.

Is that a dangerous intensity? Far from it. A man could absorb such a concentration for as long as six years in a row without appreciable harm. The X-ray doses used on the fruit flies were equivalent to millions of particles, administered all at once.

So, the 60 candidates now left of the original 1,000, armed with the facts on cosmic radiation, will know they have little to fear on that score.

But some tests lie ahead. The 60 are ready for training now—training in methods of withstanding acceleration shocks, training in group procedures within a sealed cabin, in navigation, and in personal locomotion in space. By the time the candidates have finished that instruction, there will be only five left. ▲▲▲

U.S. NAVY PHOTO

Left: high-altitude cosmic-ray tests were carried on from Coast Guard cutter Eastwind by launching balloons which set off rockets aloft. Above: preparing rocket-firing mechanism

Next Week **In a big hangar, a cage whirls around like a bucket on the end of a string; inside sits a man, his face sagging, his body under heavy pressure—but his mind working swiftly. In the next room, a space-suited figure is seated atop a slender pole with a gunlike instrument in his hand; as he pulls the trigger, he cartwheels, spins, gyrates crazily. What are they doing? They're training for the toughest assignments of their lives: the harsh, complicated, exacting duties of rocket crewmen preparing to conquer space**

APR Corner

Aerospace Projects Review

Aerospace Projects Review (APR) is presented by Scott Lowther, whose unique electronic publication is described as a "journal devoted to the untold tales of aero-spacecraft design."

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Inflatable Spaceplane

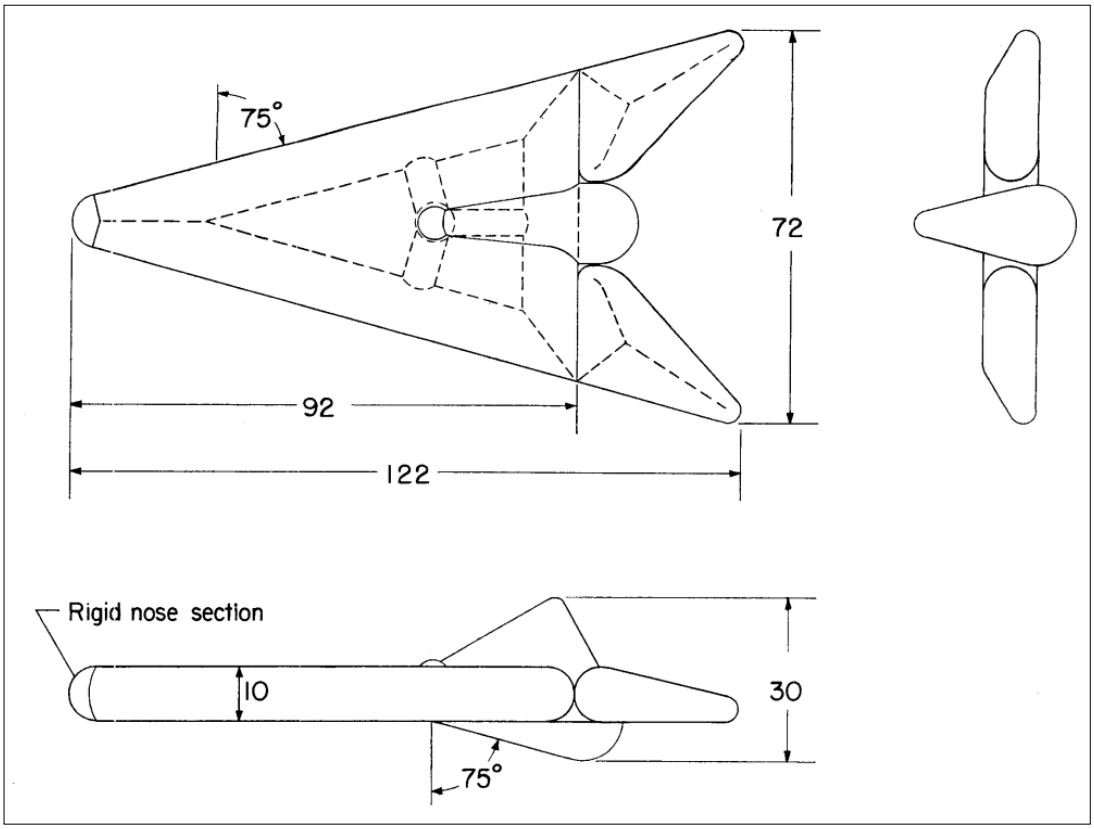
SCOTT LOWTHER, AEROSPACE PROJECTS REVIEW

Getting back safely from orbit involves one of the most challenging environments Man has yet tackled: the aerothermal heating involved in using the atmosphere to brake from orbital velocity. The math is simple: if you use the atmosphere to slow your spacecraft from orbital velocity, then all the kinetic energy that went into putting the spacecraft up there in the first place must be transformed into another form of energy… in this case, heat. It is **almost** as if the spacecraft needs to be parked directly behind the rocket engine that launched it, and the engines run for as long as they did during launch, for the same throttle settings.

A note: unlike ever science fiction movie that has ever mentioned it, the heating on re-entry does **not** come from friction with the air. Instead, it comes from the compression of the air. As the spacecraft plows into the air at many times the speed of sound, the air simply cannot easily get out of the way, and "piles up" in front of the craft. The pressure is far greater than the local static air pressure, and thus the compressed air heats up. This cannot be avoided. However, it can be dealt with in a number of ways. The ways generally used have been either refractory materials such as carbon structures or silica tiles that can withstand the heat, or ablative heat shields that melt or vaporize and take the heat away. But another approach is to use very large, but very light, heat shields.

If two spacecraft enter on the same trajectory and same speed, and have the same shape and mass, they will have similar heating issues. If, however, one of the spacecraft has a much larger surface area, then to first order the heating rates will be much reduced. A simple thought experiment will illustrate this: a one kilogram rock, and a one kilogram balloon several meters in diameter. The rock will enter as a meteor, decelerating slowly while glowing white hot. The balloon, on the other hand, will virtually slam to a stop. The acceleration will be immense, but the heating rates will be vastly lower compared to the rock. The same **total** amount of thermal energy will be converted from kinetic energy, but it will be spread over a far greater surface area. Thus the balloon might get a little warmer, but not white hot.

Several spacecraft have been designed to take advantage of the milder heating properties associated with inflatable re-entry vehicles. One such design was studied at NASA-Langley in 1960 and found to be practical. While the nose cap would be made of a high temperature solid metal, structure, the bulk of the craft would be an inflatable structure using tubes inflated to 75 psi as the primary structural elements. A two-man capsule was suspended within the inflated structure. The leading edge temperatures were held to around 1500° F; while conventional balloon materials could not withstand this, a



Above: Inflatable spaceplane. Dimensions in feet (NASA, 1960). Image credit: Scott Lowther.

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fine steel mesh cloth impregnated with a gas-tight elastomeric material could. The inflatable structure would be folded and stored during launch and while in orbit; inflation would occur just prior to re-entry. The ability to be folded for launch solved a major problem inherent with many spaceplane designs: the pitching moment produced by larger wings at the forward end of the launch vehicle. The X–20 Dyna Soar dealt with the pitching moment by adding very large fins to the tail ends of the initial Titan I and Titan II launch vehicles; a similar launch vehicle with an inflatable spaceplane would not need such fins, as the spaceplane would be packed into a non-lifting configuration.

It's not clear if the design analyzed by NASA was an in-house design or a contractor design. Several companies, such as General Electric, had devoted considerable effort to the study of inflatable manned entry vehicles.

Weight breakdown:
Structure (Wings, elevon, tail): 2,400 lbs
Pressurization system: 400 lbs
Capsule structure: 1000 lbs
Crew: 400 lbs
Escape system: 600 lbs
Power system: 800 lbs
Total: 6,000 lbs

Reference: NASA TN D-538, "A STUDY OF THE FEASIBILITY OF INFLATABLE REENTRY GLIDERS," Walter Olstad, Langley Research Center, October 1960.

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The American Institute of Aeronautics and Astronautics

Robonaut 2 Team Receives National AIAA Robotics Award

February 4, 2013, NASA article. More information about this award is presented in this issue in our Section News pages.

The NASA team behind Robonaut 2, the first humanoid robot in space, has been awarded the AIAA Space Automation and Robotics Award for 2013. AIAA is the world's largest technical society dedicated to the global aerospace profession.

Robonaut 2, or R2, is a dexterous humanoid robot built and designed at NASA Johnson Space Center in Houston, Texas. Sent to the International Space Station in 2011 with the intention of aiding astronauts on dangerous tasks and freeing them from some the more mundane work, upgrades to the R2 system continue to produce novel advances in the field of robotics.

"The R2 development team is an incredible group of talented people and I am so proud that the team has been recognized with this prestigious honor," said Dr. Myron Diftler, Robonaut Principal Investigator at NASA Johnson. "To be acknowledged this early in our planned activity on ISS is especially notable. This award from our peers gives us increased confidence that R2 is on a track to even more success as we move towards mobility inside, and then outside the International Space Station."

The citation for the award reads, "In recognition of the Robonaut 2 Development Team's pioneering technical achievement and advancement of humanoid dexterous robotics for human space exploration."

Technologies developed by the R2 team have debuted in spinoff wearable robotic devices. The Robo-Glove, designed to reduce the risk of repetitive stress injuries and provide additional gripping strength to astronauts, is a direct descendant of the actuators and controls found in R2's hands. Also drawing from the robot's design team, the X1 exoskeleton device is a robot that a human could wear over his or her body either to assist or inhibit movement in leg joints.

R2 is part of NASA's Game Changing Development Program, which seeks to quickly mature innovative technologies that will have cross-cutting applications throughout agency missions and may also be of benefit to the American aerospace industry. NASA's Game Changing efforts are part of the agency's Space Technology Program, which is innovating, developing, testing and flying hardware for use in future science and exploration missions. NASA's technology investments provide cutting-edge solutions for our nation's future.

Above: ISS030-E-075365 (14 February 2012) Robonaut 2, nicknamed R2, is pictured during a checkout and activities session in the Destiny laboratory of the International Space Station. Image credit: NASA.

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